ARCHIVES OF OPHTHALMOLOGY.

ANOMALIES OF THE OCULAR MUSCLES.

THIRD PAPER.

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With four wood-cuts.

V.—EXOPHORIA.[1]

THE term Exophoria signifies "a tendency of the visual lines outward." The condition is supposed to be ascertained when all the muscular tensions are at their minimum, especially when the exertions made necessary in accommodation are, as absolutely as possible, absent.

In order to arrive at a knowledge of the condition, the test object must be so far removed from the eye that a full relaxation may be obtained. Such a relaxation demands, not that the test object should be at an infinite distance when the distance between the eyeballs is considered, for practically a distance of not less than twenty feet will serve to place all the ocular muscles in a condition of essentially minimum innervation, and will make due allowance for what is known as the "muscular mesoropter." At this distance, then, if we induce diplopia by means of a prism placed exactly vertically before one eye, or by prisms vertically placed before each eye, the base of one exactly up, of the other exactly down, the deviation heteronymously of the images of an object in the same horizontal plane with the eye, is the indication of exophoria. The phorometer affords us the most satisfactory aid in making such an examination, for it not only avoids the inaccuracies almost unavoidable in

[1] Gr. φορά, a tending.

extemporary methods, but aids materially by revealing with ease any coexisting and complicating anomalous tendencies. The number of degrees of prism required to correct the heteronymous deviation, as shown by the vertical prism, marks the extent of exophoria.

A second condition, and one nearly always associated with exophoria, but very often found in its absence, is *exophoria in accommodation.*

By exophoria in accommodation we understand the condition answering to the same general tests as exophoria, but with the test object at the ordinary distance of reading, or about ¼ metre. It must not be understood that exophoria and exophoria in accommodation are one and the same condition, shown in greater or less degree according to the distance at which the tests are made. The two conditions may be the expressions of entirely different influences. In all our study of these anomalies this radical difference should be kept in mind.

Another important fact should not be forgotten, namely, that while in theory the position of the images of the two eyes when separated by prisms indicates the tendency of the optic axes, the fact remains that the influence of the prism in demanding an attempt at correction of the diplopia may become also an element of disturbance in the lateral relations of these axes. The method of determining the mutual relations of the optic axes by means of prisms has certain disadvantages which should be recognized in all such examinations. Unfortunately no other method at present known can take the place of the use of prisms. That exophoria in accommodation is, in a certain proportion of cases, a result of the interposition of the vertical prism, appears exceedingly probable. That the prism if not too strong is rarely the cause of exophoria, appears also fairly certain.

Our interpretation of the deviating tendencies, whether at distance or in accommodation, must depend on a consideration of all the various tests at these different distances. Thus, if exophoria appears when the test is made at the distance of twenty feet, we are to take into consideration

also the question of hyperphoria, of exophoria or esophoria in accommodation, and of the power of abduction and adduction. Only when all these are made elements of the problem can any satisfactory decision be reached.

Should exophoria be found both at the far point and in accommodation, should the abduction be in excess, and should no important degree of hyperphoria exist, we may, undoubtedly, interpret these various tests as indicating that the balancing of the eyes is such that the natural tendency of the visual lines is to diverge, and that only an amount of tension on the part of the adducting muscles greater than that required in orthophoria can hold these lines in parallel or in converging relations.

Exophoria is generally the expression of such an actual tendency to diverge. There is, however, a percentage of exceptions to this principle, a percentage large enough to keep us strictly on guard against error.

That exophoria is not infrequently the expression of hyperphoria is a fact that cannot escape the notice of the careful observer. Indeed certain cases in which hyperphoria exists are at one time high grades of esophoria, and at a somewhat later date are found to be exophoria in as high degree, indicating that the conditions of esophoria and exophoria are accidental, doubtless resulting from the existence of hyperphoria. Illustrations of this interesting fact will be adduced as we proceed.

Now, it only remains to emph ize the statement that exophoria, complicated with hyperphoria, is not unfrequently the result of the latter anomaly.

If this is true of exophoria, it is in a far greater proportion of instances true of exophoria in accommodation. Indeed it is safe to say that by far the greatest number of cases in which exophoria in accommodation occurs, its presence does not indicate any actual preponderance of energy on the part of the externi, nor any insufficiency of the interni. Exophoria in accommodation is rarely absent in hyperphoria, although the opposite condition of esophoria in accommodation is, in rare instances, found associated with that anomaly. Not only is exophoria in accommodation char-

acteristic of hyperphoria, it is quite frequently found in simple esophoria. In the case of hyperphoria the existence of exophoria in accommodation is probably explained by the effort at adjustment by the muscles moving the globe of the eye in the vertical direction. It is less easy perhaps to account for the presence of the condition in question in cases of simple esophoria. It is quite possible that the habitual tension of the externi in the act of preventing the confusion which might result from esophoria comes into action, when the prism is used to separate the images of the two eyes, in such a manner as not to permit a convergence of the visual lines exactly proportional to the angle required for the given near point. In other words, it is an instinctive resistance which, under the circumstances of the interposition of the prism, can not be exactly graduated by the muscles engaged. It is also quite possible that by the very fact of the interposition of the prism, the normal adjustments being interfered with, exophoria results. Whatever explanation we may accept for the presence of exophoria in accommodation in simple esophoria with restricted abduction, the important fact remains that we not infrequently encounter it.

Exophoria and Insufficiency of the Interni.

We are now in position to compare the condition of exophoria with the condition described by von Graefe and so well known in the text-books as "Insufficiency of the interni." According to von Graefe, "the affection consists in the insufficient power of the interni, as opposed to the resistances which arise in the binocular act of vision and which manifest themselves in an increased manner at the near point." In fact, notwithstanding a nominal recognition of the relations of the visual lines at distance, the whole line of von Graefe's argument and the entire purport of his procedures of examinations and of treatment, indicate in the most unquestionable manner that practically Insufficiency of the interni related to the reading point. One or two examples from the many which might be adduced will serve to illustrate the correctness of this state-

ment. In speaking of the tenotomy for the relief of insufficiency[1] he finds a difficulty in certain cases in correcting it satisfactorily because a full correction causes homonymous diplopia—in other words, convergent squint, at distance. He is therefore reluctantly forced to leave some of the insufficiency uncorrected. But he is willing to go as far as possible, and he therefore directs that tenotomy be carried to the extreme point of abolishing the power of abduction at distance, although he concedes that this will force the "greatest strain upon the externi" for distance in order to avoid disagreeable diplopia. Indeed he goes much further and says: "If the insufficiency increases rapidly toward the reading distance we can be more liberal (in the tenotomy), and need not fear homonymous diplopia for the distance, to correct which, directly after the operation, prisms of from 12° to 14° are required."[2]

Von Graefe even adduces as typical of a class of cases of insufficiency of the interni by no means rare, the following conditions: "Latent converging strabismus, 6°; abduction at distance, 0°; insufficiency of the interni, 20°." The reader who has pursued this series of papers can hardly fail to recognize in this combination the certain indication of a high degree of hyperphoria, an element which von Graefe does not consider in this connection.

Von Graefe's "Insufficiency," then, which has received no new interpretation in later works, may be fairly compared to the condition which we have called exophoria in accommodation. It represents, not of necessity, an actual outward balancing of the visual axes (although in point of fact slight degrees of divergent strabismus were included in his class of "Insufficiencies"), but is the manifestation, as we have seen, of various more or less complicating tensions, and may even be one of the expressions of an actual tendency of the optic axes to converge.

That exophoria demands, in the covergence necessary in the act of accommodation, an inordinate tension, and that as the result of such tension pain and fatigue are induced, is evident. Insufficient power of the

[1] *Archiv für Ophthalmol.*, viii., 2, p. 345. [2] *Ibid.*, p. 350.

interni is, however, of less frequent occurrence than might be supposed, especially when it is remembered that the condition has so long been known by the term Insufficiency of the interni. In fact the converging power resulting from the increased demands upon the interni is commonly very great indeed. The convergence of the optic axes in a large proportion of cases of exophoria (in which a low degree of diverging strabismus is not included) is for a point as near, and even nearer, than it is found in a very great number of instances where no exophoria exists. Indeed, if we select indiscriminately a considerable number of cases of simple exophoria and an equal number of cases of even moderate hyperphoria, we shall find that the average converging power in the cases of exophoria is considerably greater than in the other. The fact that more than the usual amount of effort is demanded of the interni in exophoria serves to develop the size and strength of these muscles to an extent greater than exists in orthophoria or esophoria. Hence the other fact that the converging point is removed to a greater distance from the eyes than in orthophoria may not, and most frequently does not, indicate a tendency of the visual lines outward when all the muscles are in a state of repose. The ability to converge is often much more considerable in cases where there is actual divergence of the optic axes than in some cases in which there is positive convergence. For instance, in a case now under my observation, behind a screen either eye deviates out one third the diameter of the cornea, and which shows, by the phorometer, exophoria 15 °, and exophoria in accommodation of 30 °, can fix a small opening through a dark card held toward the light, holding the image of the opening single until it reaches a point 3½ inches in front of the eyes, when one of the eyes can be seen to surrender and move outward. Examples in which, with converging axes, convergence can be made only at a considerably greater distance than this, will be given later. It follows that the phenomenon of insufficient convergence is an unsafe guide to the practical management of any anomalous condition of the muscles. Instead of relying upon this condition,

itself dependent on others, we should ascertain to what the insufficiency of convergence owes its origin. This being found, we may safely proceed to correct the original defects when the insufficiency of convergence will be found to have disappeared.

The following example will serve to illustrate the principle that insufficiency of convergence may be associated with a tendency of the visual lines inward amounting to actual convergent strabismus.

Miss G. W., aged twenty-four. Myopia both eyes (4.50 D and 10. D respectively). Has vertical and converging strabismus. A prism of 6° with its base down before the right eye, and another of 9° with its base out before either eye, unites images but does not correct the whole of the tendency inwards. Without glasses, or with glasses for the correction of the myopia, the nearest converging point is seven inches.

Thus it appears that, even in a case in which there is extreme convergence of the visual lines at a distance, insufficient convergence may exist. But the further study of such a case is instructive. Tenotomy of the superior rectus of the right eye was performed with the result of bringing the images of the two eyes to the same horizontal plane, leaving homonymous diplopia. Tenotomy of each internus was afterward made, resulting in a complete correction not only of the diplopia but of all manifest esophoria. Following these corrections there was found convergence at four inches. Thus, relaxing both interni was followed, not by diminished but by increased power of convergence.

The following is an example of insufficient convergence in a case of simple esophoria:

A gentleman, who had for many years suffered from headache and asthenopia, was found to have hyperopic astigmatism 1. D each eye. Esophoria, 4° (afterward increased, while using correcting prisms of 1° each eye, to 6°). Abduction, 2°; hyperphoria, 0°; converging power at seven inches only. Tenotomy has since been made on each internus with the result of correcting esophoria, giving abducting power of 8° and convergence at three inches.

It is evident in this last case either that the interni were weak from disuse or that there was an instinctive resistance to convergence resulting from the habitual guarding against converging strabismus. In both these illustrations it is shown that the relations of the visual lines at the near point can only be accepted as auxiliary to the examination, and that the actual governing tests of muscular balancings must be made at a distance at which all the muscles can be supposed to be in repose.

Physiological Considerations.

Exophoria is an anomaly of the ocular muscles which I have found in much less frequency than esophoria. Indeed, the cases of esophoria exceed those of exophoria in the proportion of more than two to one.

When the relative physiological power of the externi and of the interni is considered, we may well question whether exophoria is often a congenital defect or whether it is not in most cases acquired.

The facts now available do not appear sufficient to warrant any assertion. That exophoria is the congenital condition in a certain proportion of the cases is strongly suggested by the fact that it is so often a family trait, and to all appearances one in which no collateral anomaly is to be discovered which might account for this. Even in cases of well marked and uncomplicated exophoria, the interni retain a considerable preponderance of contractile power.

In practice, the well-known fact that a free tenotomy of an externus produces, compared to a similar operation on an internus, a much less pronounced effect, is an extremely suggestive one in respect to the relative tension of the two opposing sets of lateral muscles.

Still another interesting fact in this connection is that which I have observed very generally in operations upon the externi, that the tendon of the externus is rarely tense, even when the eye is rotated in. In this respect it differs materially from its opponent, the internus.

It is certain that exophoria is not, in all cases in which it exists, an original condition. Just as hyperopia is some-

times observed to pass over to the opposite condition of myopia, so is esophoria sometimes replaced by exophoria. The existence of hyperphoria is usually the explanation of this change. The following case will illustrate this principle. As in several instances before, the illustration is selected from a class of cases representing deviations greater than are properly included in heterophoria, because by these extreme cases the principle can better be shown than in such cases as are of less pronounced character.

Miss C. was examined first by me in March, 1881. She appeared at that time to have slight converging strabismus. Tests with a vertical prism showed homonymous deviation of 12°, and a screen placed before one eye caused that eye to deviate in. Changing the screen quickly to the other eye demanded from the eye just uncovered a movement outward for fixation. She had from childhood been slightly cross-eyed, the right eye deviating in, but she was able, within certain limits, to correct the appearance of squint.

Nothing was done at that time, and she was seen again, in January, 1889, nearly eight years later.

She now exhibited a diverging squint nearly as pronounced as was formerly the converging deviation. The right eye now appeared to float outwards, while the left habitually fixed the object. Covering the left eye, the right moved inwards in fixation. Changing the cover quickly, the left made a corresponding movement.

Tested by the phorometer she showed exophoria or esophoria, depending upon her will ; right hyperphoria 2° to 5°. After using a prism of 2° for right hyperphoria nearly a month, the extent of hyperphoria did not appear to vary much from 5°. February 11th tenotomy of the superior rectus of the right eye was made.

February 12th.—Hyperphoria, exophoria, and esophoria, each 0°. The appearance of strabismus had disappeared.

June 3d.—Still no appearance of strabismus. Hyperphoria 0°, esophoria 3°, with no deviation behind the screen. Patient had experienced great relief from certain nervous symptoms, which had previously been very annoying.

That the lesser tendencies of heterophoria not very unfrequently pass from esophoria to exophoria appears to be established by many observations.

From such facts we may reasonably conclude that great circumspection should be observed in respect to operative treatment of exophoria. All tests should be found to agree, and the question of a primary influence behind the condition of exophoria should always be settled before any resort is made to operative measures.

Resulting Symptoms.

The general symptoms of exophoria differ in some respects from those of esophoria. While the latter is more often the cause of pains in the head, in the back of the neck, at the seventh cervical vertebra, at a point between the shoulder-blades, and of many other more serious nervous disturbances, exophoria is more frequently the cause of asthenopia. Yet all the reflex symptoms of esophoria are to acertain extent common to exophoria. Among them are found some of the most important of the neuroses: epilepsy, mental disturbances, headaches, and neuralgia are examples.

Manifest or Latent.

In determining the extent of exophoria, it is important, as has already been shown, to exclude complicating tensions. If, by the phorometer, a certain extent of exophoria is indicated, if the abduction is in excess of 8° in proportion to the manifest exophoria, and if an important degree of hyperphoria is absent, we may assume that we have a case of uncomplicated outward tending of the optic axes. Even in such a case several examinations should be made to confirm this conclusion. The presence of exophoria being established, we have to determine approximately the extent. The manifest deviating tendency, as shown by the phorometer, no more indicates the absolute exophoria, than does manifest hypermetropia, as shown by the glasses of the trial case, indicate the total hypermetropia. In case of exophoria we may resort to the temporary employment of prisms for the purpose of revealing, approximately, the amount of the defect.

It is my custom to give temporary prisms of less than the full correcting power. The correction should fall behind the defect from one to several degrees. Should we make an absolute correction by prisms, we are liable to lead to an apparent defect, while, by following, we discover only what actually exists.

Treatment.

In slight or moderate degrees of exophoria very important relief to the asthenopia or even to some of the more serious reflexes may be secured by systematic exercises in overcoming prisms. Prisms of gradually increasing strength and with bases out should replace each other in rapid succession until the full extent of the patient's ability to overcome and unite images at twenty feet is reached. Commencing again with the lower numbers the prisms are again built up until diplopia cannot be corrected. Again and again the process is renewed during three or four minutes at a sitting. On the following day the patient will commonly accomplish the union of images with higher grades of prisms, and the exercises should be repeated from day to day until the union of images with prisms amounting to 50° is accomplished with ease.

In cases of doubt or in cases in which for any reason tenotomy is undesirable, this method is safe and often, at least temporarily, effectual.

Concerning the employment of correcting prisms, prisms with the bases in, what has already been said in speaking of the method of ascertaining approximately the extent of the defect, is applicable. Although accustomed to use many hundreds of such spectacles every year for such diagnostic purposes, I rarely find that they afford any considerable relief. Indeed, asthenopia and general uneasiness more frequently result from such prisms than does marked relief. Nevertheless, in a certain not very considerable proportion of instances, the prisms are restful, and important relief is gained.

Of all methods for the relief of exophoria the actual balancing of the opposing forces of the lateral muscles is

the only radical and permanently effectual cure. Tenotomy most frequently accomplishes this result. The method of performing tenotomy for these defects, of less extent than strabismus, has been described in the former articles of this series, and it is unnecessary to repeat the description here. It may, however, be well to remind the reader that a wound through the conjunctiva over the insertion of the externus leaves a much more conspicuous cicatrix than a similar wound over the insertion of the internus. Hence the greatest caution should be exercised to make the conjunctival wound the smallest possible. It should not exceed one half a millimetre in extent. Moreover, great care is required that the points of the scissors should, in making the opening, stand at a right angle to the surface of the membrane, thus avoiding even the slightest approach to a flap.

If a considerable effect is to be produced, this may be better accomplished by combining a very careful tenotomy of the externi with tendon contraction or tendon resection of the interni. The methods of making tendon shortening and tendon resection have been already described by me.[1]

These operations have great advantages, in the class of cases under discussion, over operations for advancement such as have been previously described. For cases in which only a slight effect is desired, for example, when it is proposed to make a correction of two or three degrees, shortening by tendon contraction is sufficient. If, however, more considerable effects are to be obtained, tendon resection is required.

In making **tendon resection,** the proceeding which I have adopted is as follows:

With the narrow-pointed scissors used for subconjunctival tenotomy, which are figured in connection with the second paper of this series,[2] an opening is made in the conjunctiva less than one millimetre in extent and about a millimetre posterior to the insertion of the tendon and exactly over its central portion. The opening should be the smallest possible, not more than sufficient to expose a

[1] *New York Medical Journal*, March 30, 1889.
[2] See ARCHIVES OF OPHTHALMOLOGY, No. 2, 1888, p. 186.

small point of the surface of the tendon. The fine tenotomy-forceps[1] is then introduced, its branches closed, through this small opening and forced backward, when, by removing the pressure of the fingers, the expansion of the blades pressing against the elastic tissues surrounding them causes the opening to expand, thus temporarily enlarging the wound and permitting the operator to grasp, in the teeth of the forceps, a small fold of the tendon, slightly removed from its insertion. With much care the tendon is divided transversely, half a millimetre behind the insertion, carrying the division each way, as in the case of graduated tenotomy, until the border of the tendon is reached, which is to be preserved. As the division is carried toward the borders the section is more exactly on the sclera. The object of leaving a very narrow strip of tendon at the centre is to furnish support for the suture at a later stage.

With the fine traction-hook (Fig. 1) the central portion

FIG. 1.

of the proximal lip of the tendon opening is then drawn forward through the opening in the conjunctiva, which, without tearing, expands to allow of this procedure. While the tendon is thus held forward the small plow or divulsor (Fig. 2) is insinuated and pushed backward over all the parts

FIG. 2.

of the tendon behind the wound, effectually releasing the tendon from any connection with surrounding tissues.

This separation of the tendon will permit it to be drawn forward without causing so much of a fold of the conjunctiva as is otherwise likely to result if the tendon is much shortened. The tendon being now drawn forward to an extent equal to the amount of resection desired (and the resection must be made to conform to the extent of short-

[1] *Ibid.*, No. 2, 1887, p. 176.

ening proposed), either making traction by means of the traction-hook or by the fine fixation-forceps (Fig. 3), which

FIG. 3.

may be made to replace the hook, and using as much care as possible not to enlarge the conjunctival wound, a cut is made from each extremity of the transverse incision in the tendon backward so that the two cuts nearly meet just behind the insertion of the forceps. By this means a triangular piece of tendon is very nearly removed. Making traction now with the fixation-forceps, which holds the bridge at the apex of the triangle, the needle, armed with No. 000000 silk thread, is passed through just behind the apex of the triangle, when the resection of the triangle is completed. The needle is next carried through the corneal extremity of the tendon and the extreme border of the conjunctival wound, including, not to exceed one millimetre, when the suture is to be tightened and secured.

FIG. 4.

Figure 4 shows the needle-holder which I have devised with the view of avoiding the snap which is experienced from the ordinary forms, and with the view of having a needle-holder corresponding in delicacy to other eye instruments.

The object of the fixation-forceps is to maintain a hold upon the exact central portion of the tendon. Should resection be made without the precaution of thus securing this part, it would be doubtful whether the exact angle of the resected part could be readily found afterward. This may be done approximately, if the fixation-forceps has not been used, or if the hold has been lost, by carrying the slender hook beneath the tendon after resection is made, observing special care as to its direction so as to draw the angle forward. It is much better, however, to secure this point from the beginning, when it is possible to be very precise.

During the different stages of the operation, the conjunctival wound, originally very small, is in danger of being enlarged by tearing or cutting, but this should, as far as possible, be avoided. The tissues are susceptible of a considerable degree of stretching, and what may during the operation appear like an opening of two or three millimetres will, after a few minutes, contract to a small point. The amount of tissue to be removed in the resection must, of course, as has already been intimated, be graduated by the effect desired. The surgeon should determine beforehand the extent to which it is desirable to change the relative position of the eye. The distance from the base to the apex of the resected triangle should correspond nearly to the extent to which the eye is to be rotated.

If the operation is made for the correction of the results of an excessive tenotomy previously made, and in which the insertion of the tendon has been allowed to fall back, the points of the scissors may, before drawing the tendon forward, be turned toward the cornea, and a pocket between the conjunctiva and sclera may be made. The needle, instead of passing through the corneal extremity of the tendon, may be carried further forward, and in returning pass again through the conjunctiva from without to within. Thus, on tightening the suture, the end of the tendon is drawn forward into the little pocket.

In making **tendon contraction,** the conjunctival opening is made as already described. Then the tendon is drawn slightly forward through the opening and is cut transversely toward each border. The small traction-hook is then introduced beneath the tendon, which it draws forward. The needle is carried through the tendon as far back as necessary. If it is carried so far back as to leave in front of it any considerable extent of the tendon, this may be shaved off by the scissors so as to leave a very thin border. The needle is then carried through the anterior lip of the tendon as has already been directed, and the suture secured as before. Before finally tying in either case the patient should be tested in respect to the result, when, if it is excessive, the suture may be loosened before the knot is

secured, and, if insufficient, the operation can be carried further.

No extensive cicatrization occurs after such operations, The tendon is not bound to the sclera or to the conjunctiva. Union takes place by first intention, hence there is very slight prospect of losing the result of the operation, although, owing, to the elasticity of the parts included in the suture, an excess of effect should be temporarily induced. Owing to the extreme fineness of the thread, no inflammation is set up about it. It may be removed after five or six days, or it cuts its way out without assistance. A few weeks after such an operation only minute traces of it can be discovered. No unsightly scar and no adhesions are left to remind the patient or the surgeon that an operation has been done.

VI.—SOME CONSIDERATIONS RESPECTING THE DEVIATIONS OF STRABISMUS AND THEIR TREATMENT.[1]

From the time when John Taylor went from city to city in Europe advertising the cure of strabismus by operation, to the time when the Academy of Sciences of Paris awarded the grand prize to Strohmeyer and Dieffenbach, to the one for the suggestion, to the other for the execution, of the operation, which had already been practised a century before by the itinerant oculist, the correction of squint was in the hands of the charlatan only.

From 1840 to the time of the important contributions to the subject by Donders and von Graefe, progress had indeed been made, yet even at this time a large proportion of respectable oculists preferred to permit their patients to endure the defect of strabismus rather than risk the deformity of the then so frequent over-corrections.

The method of making the section through the tendon near the sclera instead of making it in the course of the muscle, marked a great advance in the history of the operation. The investigations of Donders respecting the rela-

[1] This general section was read under the above title at the meeting of the AMERICAN MEDICAL ASSOCIATION at Newport, June 26, 1889.

tions between strabismus and refractive anomalies was another important step in the theoretical knowledge of this interesting subject.

Since these signal additions to the knowledge of strabismus, it cannot be said that any remarkable progress has been made by the profession at large, and it is safe to say that the theory and the practical management of strabismus remain very nearly where Donders and Graefe left them more than twenty-five years ago.

The subject in many of its bearings remains still obscure, and still the operations are made mainly for cosmetic purposes.

Rightly understood there is perhaps no department in ophthalmology which demands a wider range of study, or which will afford more gratifying results to scientific labor than these anomalous relations of the visual axes.

The lines upon which theoretical research and practical procedure must advance appear to me to be, first, a more systematic examination and appreciation of the unequal tension of the muscles, in every possible relation, than has hitherto been usually demanded; what is needed is not so much the addition of new facts as the better interpretation of facts already at our hands. Second, a well directed attempt in every instance to establish not simply cosmetic improvement but binocular single sight in the whole range of ordinary vision. This last part of the proposition is to be emphasized. The attempt is to be made, not only to establish binocular sight, but binocular seeing in the whole range of ordinary vision. The second part of the proposition depends upon the first.

The first of these lines of research appears to me to demand a change in the procedure of examination. Not that radically new means are required, but that a more systematic and thorough employment of known means should replace some loose and thoroughly unscientific methods long in vogue. Donders has already taught us to examine the refraction; there are many other details for us to study before we understand even the simplest of strabismic cases. Beyond question it is all too common for the surgeon to

proceed to sacrifice the continuity of a tendon in a perfunctory manner without having made adequate examination of the relations of the organs upon which the operation is to be performed, and without due consideration of what will be the resulting loss of motility of the eye subject to his operation, or of what will be the precise relation of this eye to its fellow when the supposed cure is completed.

If we ask ourselves what real technical information is gained by the methods which are laid down in our ordinary text-books for examination in strabismus we shall find it inadequate. It should be admitted without discussion that the precise relations of the visual axes to each other, measured not in linear measure but in angles and in every possible relation, must be determined before we can possess any sufficient knowledge of the necessities of a given case. Rightly considered, what could be further from a correct method than a determination of the deviations of visual lines by linear measure? The delicacy of balancings inwards and outwards, upwards and downwards, cannot by any possibility be estimated by any such method. Strabismus is rarely a simple condition. That this observation does not conform to the generally accepted view appears to be shown by the fact that it is rare to find a case which has been treated by operations for any but the simple conditions of convergence or divergence, or, with rare exceptions, for vertical deviation.

Determination of the Relative Tensions.

In order to proceed successfully towards the attainment of perfect binocular single vision, we must become fully acquainted with the details of the relative tensions of the various muscles of the two eyes. Nothing but a knowledge of the relative positions of the respective images of the two eyes will serve in this respect. The first step then in the process of an examination in a case of strabismus is to determine this point. To do this, in many cases of concomitant squint, is no easy task. Indeed it is believed by many that it is impossible in a certain number, if not in a great proportion, of instances in which considerable deviation

exists. Contemporary literature shows that this belief is very prevalent, and that in the majority of cases no measurement beyond the linear is attempted to be made.

My own experience leads to the belief that the proportion is quite small in which diplopia cannot be made manifest to the patient. Great patience and some skill are frequently demanded in these cases. It is not an infrequent experience that a strabismic patient is required to make long-continued trials, day after day, for a whole week, and in some instances for even a longer period of time, for the single purpose of learning the position of the double images. The patient often meets my assurances that he or she is seeing double images with the most emphatic counter-assurance that he or she does not see double images of the same object, and that it is useless to attempt to convince one of a physical impossibility. A kindly encouragement that, with patience, the surgeon and the patient will at last understand each other, with possibly some explanation of what is expected, induces the patient to persevere in the effort. The room is darkened, a lighted candle is at the farther end, a red glass is placed before the best seeing eye, and then prisms to change the position of the images in all directions are used. With every change of prism, or of the colored glass, the patient is told what change is made in the relation of the images. This process is continued for twenty minutes or more, and repeated day after day until success at last crowns the effort. Perhaps after repeated sittings the patient, in the midst of one of these trials, suddenly exclaims: "There, I see two now, but I know that I have not seen more than one before." This remark is a surrender. Little difficulty occurs after this first discovery.

The next stage of the examination is the determination of the actual balancing of the muscles. One who has not practiced this form of examination habitually will be astonished to find how few of his cases are simple convergent or divergent strabismus. A recent text-book on ophthalmology says: "We often find, along with a pronounced lateral deviation, a slight deviation upward or downward." No practical deductions are made from this proposition, and

one has only to glance over the statistics of operations in the various eye hospitals, and to read the current literature of strabismus, to learn that these "slight deviations" are rarely taken into account.

It will perhaps be thought to be an extreme statement when I declare my belief that the search for these upward and downward deviations is of vital consequence in every instance, and that in general they should receive first attention in the treatment of the case.

In the practical examination of any case (vision existing in both eyes) we are to assume that in every instance in which the axes of the two eyes are not in normal relations diplopia exists. This proposition is denied by Schweigger and others. I shall not here enter upon a discussion of the merits of the proposition, but shall proceed not only upon the basis of its truth, but shall further insist that not only are we to assume the presence of double images, but that before we proceed to a final correction we are to find these images in the relative positions in which they should be according to the theory of identity—that is, the theory that objects appear single when their images fall upon identically corresponding parts of the two retinæ, and that they are double when the images fall upon points not corresponding.

To the end that we may locate these double images in every instance, we may properly divide the cases of strabismus into two very general but not well-defined classes—the moderate and the extreme. Between these classes there is of course no actual dividing line, and the classification is simply one for convenience. In the moderate cases the presence of diplopia can, as I believe, in every instance be made out. In cases of extreme deviation the difficulties are often great and the time required to demonstrate the diplopia might well be spared. Indeed the patient might after long-continued efforts refuse to acknowledge the presence of diplopia. For convenience we will discuss the method of examination first of the class of moderate deviations and then pass to the other class.

The tests by the perimeter which are described in some of the text-books, do not appear to me to be of sufficient

accuracy to serve the purpose of determining the relations of the visual lines for the practical purposes of treatment. A method of perimetrical examination described by myself at the International Medical Congress at Washington in 1887,[1] is more satisfactory, but even this method is better adapted to cases of paralysis than to ordinary cases of concomitant squint.

I find that the use of prisms, first to determine the deviations from the horizontal plane, then from the vertical and finally in complex directions, serve the best purpose. It is often desirable to place a red glass before one of the eyes, preferably before the one most used in fixation, and then to proceed by the use of prisms to ascertain to what degree one image falls below or rises above its fellow, then in the same manner to determine the extent in degrees of the deviation in a lateral direction. When enormous prisms are required for the lateral displacement of the images, the determination becomes less and less satisfactory so far as the degree of deviation is concerned. Fortunately this is not of vital importance, inasmuch as beyond a certain point tests of this description are only of approximate value. In moderate cases only can a fairly accurate determination be made. Next, tests are made by means of the phorometer, permitting a comparison to be made between the results obtained by the two methods. The phorometer can of course be of service only in cases of moderate deviation. The comparative power of the various muscles in rotating each eye in adduction and in abduction, in sursumduction and in deorsumduction should be thoroughly tested, not in reference to the co-ordinate movements of the two eyes, for these are not established, but in reference to the movements of each eye independently. This determination of the relative mobility of the two eyes, inward and outward, in cases in which strabismic operations have already been made, is of a special consequence. The comparative extent of rotation must often serve as guide to all of our procedures. The movements of the eyes should then be carefully observed while a screen is passed first before one and then

[1] Transactions Ninth International Med. Cong., 1887, vol. iii., p. 735.

before the other, and while the patient is directed to fix a distant object—for instance, a lighted candle. Not only may we observe the movement of the eye as it passes from its passive state to the state of direct fixation, but we may learn something from the patient respecting his consciousness of the change of position of the image as the eye comes into position of fixation. The precise direction of this apparent movement of the object as seen by the patient may sometimes, though rarely, be an aid in determining the direction of deviation.

It must not be supposed that these various tests will always prove satisfactory or uniform. Indeed the incongruity of tests is not unfrequently a source of perplexity to the surgeon. Thus in regard to the diplopia tests, it is not rare that in a case of marked divergent strabismus in which the examiner naturally looks for crossed double images, distinct homonymous diplopia will be found, a condition only to be expected in convergent strabismus. Such contradictions are by no means rare, and the investigator who is not prepared to find them and to interpret them will find himself in an embarrassing position if he is attempting to do exact work. Further on, cases of this character will be reported in illustration of these perplexing conditions. Again, movements apparently outward and inward behind the screen are not unfrequently in reality only the effect of a swing depending upon the unequal tension of the superior and inferior recti. Indeed a considerable number of cases of apparent converging or diverging strabismus are neither the one nor the other, but are cases of vertical deviation made lateral by the strong instinct of the patient to relieve a vertical diplopia, and in such cases the habitual tension of the muscles continues in many instances even when one of the eyes is concealed by the screen. The true relation of the muscles may not be revealed at first, and in such cases only the most careful deductions from all the facts ascertainable by all the various means of examination after repeated trials should be accepted as the correct interpretation.

Tests for binocular vision or for the deviations of the axes should also be made at near points. All the preceding tests

should be made at a distance of not less than twenty feet. For the near tests, the distance may be selected according to the circumstances, within a range of from a few inches to one or two feet in advance of the eyes. These tests at near points should always be regarded simply as checks upon the tests at a distance. They may call our attention to certain conditions which would not otherwise be observed, but tests at near points should never be made the basis of treatment. The use of such tests in forming a conclusion in regard to the actual deviations will be illustrated as we proceed.

After the patient has been well trained in the recognition of diplopia, a brilliant point—for instance, a small opening in a dark-colored card held between the eyes and a strong light, or some object chosen for its strong contrast with its surroundings—will in general serve the purpose at the near point. The stereoscope has been extensively used and is of much value when the objects seen are not ordinary pictures but diagrams complete only when blended under the influence of binocular vision.

Allusion has already been made to the phenomenon of double images appearing in positions relatively different from those in which, considering the character of the deviations as judged by the appearance of the eyes or the movements of the eyes when passing from the position of passive repose behind a screen to active fixation, we should expect to find them. This phenomenon has been one of the strong arguments that binocular vision may exist in actual squint, as the images do not correspond with the theory of identity. An explanation of this state of things not unfrequently involves great difficulties. Patient observation will, however, often help to solve the question. In a certain proportion of instances an explanation, perhaps not altogether satisfactory, of this anomalous condition can be found in the change that is made in the position of the eyes in alternate fixation. One axis and then the other turns towards the object, and the resulting impressions seem to constitute a sort of mental adjustment resulting from these alternate physical efforts.

In another and larger proportion of cases not the slightest

change of direction of the axes of the eyes can be detected by the observer, while the patient gazes with both eyes uncovered, even when the most careful scrutiny is made. Both eyes of the patient appear to be immovably fixed, and still this anomalous diplopia occurs. The phenomenon is, most frequently, the expression of a decided preponderance of some of the muscles which act in the vertical direction over their more immediate opponents. That is to say, it is an expression of hypertropia. In a smaller number of instances it is the expression of a decided difference in the rotating action of corresponding lateral muscles; for instance, the difference in the rotating power of the two interni after an operation for converging squint when the severed tendon has been well "set back." Cases of this latter class are among the most perplexing of all the varieties of strabismus.

It may be generally stated that the presence of these anomalous forms of diplopia should suggest the condition of a strong tendency, or an actual deviation, of one visual line much above the other, or of greatly disproportionate rotating power of corresponding lateral muscles. Unless some other causative condition can be discovered, one of the above states should be assumed, unless it can be positively disproved.

Thus far we have considered the method of investigation in cases sufficiently moderate to permit of practical use of diplopia tests. There is a large class of extreme cases in which diplopia tests can either not be made, or in which they can afford little information. It is my custom, after as careful examinations as I can make by observing the various movements of the eyes, to proceed, not to a correction of the strabismus, but by operation to convert an extreme case into a moderate one. This may be done by one or more operations. Such operations may be required on one and then on another lateral muscle, or upon a vertical and then a lateral muscle. The object is to approximate the visual axes sufficiently to enable the patient to acquire such a knowledge of the positions of the double images as to form a guide for subsequent treatment.

Systematic Classification.

We are met at the outset of these examinations with a practical, although by no means essential, difficulty in classification. When we have succeeded in ascertaining a certain amount of deviation from the horizontal and vertical planes, we have scant means of expressing these results except by a full description in many words. A system of terms to express these deviations of strabismus similar to that which I have suggested for the lesser degrees of deviating tendencies[1] appears to me a not unimportant element in the study of strabismus. Had I not already proposed one such system of terms, I should feel perhaps less hesitancy in offering one for these conditions, but the importance of a more systematic method of description, and one which shall be in harmony with that already proposed for the lesser tendencies, must be my excuse for a further extension of this system of words. The word employed as the central idea for terms to express the faulty muscular tendencies less than actual deviations was φορά,[2] a tending. Hence we had the words, Orthophoria, Heterophoria, Hyperphoria, Esophoria, and Exophoria; expressing respectively, parallelism of the visual lines, the absence of such parallelism, a tendency of one of the lines above the other, a tendency of the lines inward, and a tendency of the lines outwards. Combining certain of these terms we may represent complicated conditions, as, for instance, hyper-esophoria, indicating a tendency of one of the lines higher than the other, and also a tendency of the lines inward.

If now we adopt the Greek word, τροπός, a turning, for the basis of terms for the more extreme conditions of actual deviation of the visual lines, we shall have a corresponding system of terms, as follows:

HETEROTROPIA, the general statement of deviation.

HYPERTROPIA, the deviation of one visual line above the other.

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[1] *New York Med. Jour.*, Dec. 4, 1886. ARCHIVES OF OPHTHALMOLOGY, No. 2, 1887.

[2] Improperly printed in former number, φορος.

ESOTROPIA, the deviation of the visual lines inward.

EXOTROPIA, the deviation of the visual lines outward.

Compound terms are formed in a manner similar to that employed in the former system of terms.

Practical Application of Principles.

We may now consider the practical application of the facts ascertained by such an examination as we have outlined.

Should we find the images in the same horizontal plane, and agreeing in relative position with the theory of identity—that is, if we have with converging deviations homonymous, or with deviations outwards heteronymous diplopia, we have next to inquire whether at the near point the conditions correspond with those at a distance. If not, we are not to accept the result, but to search further for the cause of the contradiction.

Illustrations of the disregard of this principle may be found in some of the best works on the subject of squint. If at a distance we have homonymous diplopia while the images cross at a near point—that is, at a point further in advance of the eyes than the ordinary near point of convergence, we may well doubt the diagnosis of simple converging strabismus. In simple converging strabismus the convergence for near points is nearly always in excess. Rare exceptions to this rule should only be accepted as exceptions after the most conclusive experiments. In such cases we are to be on our guard for hypertropia. The tendency to deviate in the vertical direction may be concealed, but it is rarely, in such cases, absent. Should the images not be found in the same plane, this condition should, as a rule, receive first attention. Exceptions to this rule will occur to the intelligent surgeon. Thus, should the vertical deviation be very slight while the lateral deviation is great, at least a partial correction of the lateral squint may first be made. The correction for the vertical deviation, should it still exist, may then follow, and finally the complete correction of the lateral deviation. The end to be attained is perfect binocular vision in the

whole range of sight, from the near point to infinite distance. A single operation can rarely accomplish this, and it is more creditable to the surgeon that he advance by several very cautious steps toward the end so greatly to be desired, than that he should make a brilliant though less successful leap.

The method of investigation and of procedure in such cases I cannot better describe than by the following illustrative case, which is a typical one of a large class.

Miss H., aged 30, a lady of superior intelligence, and able to describe what she saw, was first examined October, 1888. She had always been strabismic, having at the time of her first visit a very marked diverging squint. She was able to fix either eye separately at will. The left eye appeared to fix more frequently than the right, but she sometimes changed the eyes while looking at an object without thinking of the change. While fixing an object at twenty feet distance with either eye, the other deviated outward more than two thirds of the diameter of the cornea. After a half hour of attempts made in a darkened room, and with every known device for inducing the recognition of diplopia, she was quite unable to become conscious of double images. On admitting the light to the room, and studying the relative movements of the eyes in alternate fixations, a small screen being passed quickly from before one eye to before the other, thus causing alternate fixation, and observing the eyes with the greatest care, as nearly as could be ascertained, after many trials, the eyes appeared to move exactly in the horizontal direction. Not the slightest vertical deviation could be detected by myself or by my assistant, Dr. Boyer. On the third day, after a long sitting, and with much patient and intelligent effort on the part of the lady, she was able to recognize the double images, if a partial correction of the relation of the visual lines was made by placing a prism of 20,° with its base inward, before one of the eyes, or with a prism of 10° similarly placed before each eye. That this correction did not neutralize the deviating relations, was shown by the fact that still while using the prisms, either eye deviated outward behind a screen, and that if a screen was passed from before one over before the other eye, the uncovered eye was forced to make an excursion inward of more than half the diameter of the cornea in fixation. With such a prism, and with a red glass before one eye, the patient now

realized diplopia for the first time, but not with crossed images, as might have been expected; the images were homonymous. They could not be made to unite by the help of any prism or combination of prisms. There appeared, however, with this arrangement, to be left hypertropia of 6° or more. This condition appeared to be pretty satisfactorily determined, for the action of prisms in this direction was very prompt and decided. On the succeeding day, after a very careful study of all the phenomena, and finding them substantially as before, it was determined to make a partial correction of the diverging squint. Tendon resection of the internus of the right eye was made. Immediately after this the deviation appeared to be about one third corrected, and there was still homonymous diplopia. Five days later the left eye was treated in the same manner as the right had been, and the eyes appeared in much better relation, but still with moderate outward deviation. Homonymous diplopia still existed, with left hypertropia of 5° or 6°.

On November 23d, after several examinations had been made on different days, and after much time had been spent in carefully locating the images and comparing the relative rotation of the eyes, it was found that with a prism of 8°, base up before the right eye, or base down before the left, the images were satisfactorily in the same plane (showing left hypertropia), when suddenly she obtained crossed diplopia for the first time. A prism of 10°, with its base in, now united the images. We had, therefore, as nearly as could be determined, left hyper-exotropia 8° ⌊ 10°.

Tenotomy of the superior rectus was then made, which appeared at the time exactly to correct the hypertropia, but it was found on the following day that there was a slight over-correction. By means of a suture the effect of the operation was modified, and the images were again in the same plane. Crossed diplopia was now constant whenever the red glass was used, and on December 11th a further careful tendon shortening of the left internus was made. From this time there was no heterotropia, but there remained heterophoria. A moderate right hyperphoria and exophoria demanded, for accurate adjustments, very careful operations for shortening the superior rectus of the left eye, and then for relieving the tension of each of the externi by graduated tenotomies.

Single vision was fully established in the direct line at all ranges between four inches and infinite distance. At present if she looks

far to either side, slight diplopia occurs. This, however, is becoming less and less noticeable as the tendons regain their flexibility, and it will doubtless wholly disappear after a few months.

The plan which was adopted in the case just related may be wisely adopted in the class of extreme deviations either of divergence or convergence. The extreme deviations may first be reduced by operations, which shall not disable any muscle, to moderate deviations, in which the double images can be recognized. From this point the more accurate and final adjustments may be made.

Antipathy to Single Vision.

I have referred to the fact that in the early stage of the examinations in the case which I have above related, after the ability to recognize double images was established, there was no possibility of uniting these images by prisms. Even after the divergence had been reduced to a very moderate extent, the images still refused to unite under any circumstances until a correction of the left hypertropia had been made. Had a full correction of the outward deviation been made by free tenotomies of the externi, we should have had, without any doubt, an illustration of the condition which was termed by von Graefe "antipathy to single vision." However this may be, my experience leads me to believe that by procedures carefully made in every instance this so-called "antipathy to single vision" may be eliminated. This peculiarity has been located, by various authorities, in the brain or in the faulty projection of the image from one retina or from both retinæ. Schweigger, speaking of this class of cases, in which only slight deviations exist and yet in which the patient cannot be made to see single, remarks: "Binocular vision does not exist even for distance. The reason does not lie in the impossibility of fixing the same object simultaneously with both eyes, for the objectively proved deviation may be extremely slight. A union cannot be obtained even with prisms. If crossed double images are present close together, a prism of a few degrees base inward suffices to make them homonymous."

It is with no disrespect to the great authority of von Graefe that I declare my entire disbelief in any theory of physiological "antipathy to single vision." Such a phrase rightly interpreted means inability on the part of the surgeon to discover the real relations of the eyes. Patient search and accurate procedures will in nearly every instance resolve these cases of antipathy to single vision into cases of accurate binocular seeing, and the exceptional cases probably depend upon the failure of the surgeon rather than upon any intrinsic anomalous condition of brain or retina of the patient.

It is not to be inferred that with our present knowledge of methods of diagnosis and of treatment every case of inveterate diplopia of this class will yield to our efforts, but the state of mind on the part of the surgeon which frankly concedes his own limitations of knowledge is far more favorable to success than that which relegates his case to the region of the impossible. Many interesting cases belonging to this class might be adduced in illustration of the views here taken, were it consistent with the scope of this paper.

Evil Results of Unequal Rotation.

Among the cases of double vision which I encounter frequently, is a class in which converging or diverging strabismus has been supposed to exist, and for which full tenotomy on an internus or an externus has been performed, crippling the eye in its rotating movements, sometimes giving it a goggled appearance and leaving diplopia. The discovery of hypertropia in many of these cases leads to the strong suspicion that there may never have been any very important lateral deviation, that the swing from the hypertropia gave rise to an apparent convergence or divergence for which the operation was made. Such operations on the lateral muscles leave the patient with possibly less appearance of squint, but with far worse optical conditions than before the operation was done. Indeed, a not uncommon cause of difficulty in obtaining perfect single vision at all ranges is the restriction of rotation of the eye which has been subject to the standard operation for strabismus. I think that I hazard little

in saying that the operation for strabismus as described by von Graefe, and in the text-books of ophthalmology generally, is incompatible with complete binocular vision. Graefe states the proportion of binocular vision obtained by him at fifty per cent., but when we examine the methods by which binocular vision was determined by him it is reasonable to doubt whether these figures express any thing further than the ability to fix the eyes upon some given point for the moment only. Statistics, which do not state the range and all collateral circumstances respecting binocular vision in such cases, possess very little value.

A truth which cannot be too strongly presented, although in direct conflict with the teachings of von Graefe and later authorities, is embodied in the following maxim:

Every modification of the length of a lateral muscle, by relaxation or by shortening, which can in any degree effect the rotation of an eye, must in every instance be accompanied by an exactly equivalent modification of the corresponding muscle of the other eye.

The precept universally taught, that a moderate strabismus can be effectively treated by the setting back of a single muscle is entirely inconsistent with any system of ballancing of the opposing eye muscles, or of establishing perfect binocular vision.

Equally prejudicial to perfect results is the practice of making an extensive setting back of one muscle and a moderate or slight setting back of the corresponding muscle of the other eye.

Nor can the setting back of one muscle and the advancement or shortening of its immediate opponent of the same eye be expected to result less unfavorably.

General Principles Restated.

The principles to which I have desired to call attention in this section may be briefly stated as follows:

1st. Results of examinations for strabismus should be expressed in angles and not in linear measurements, these latter being unscientific, misleading, and often pernicious.

2d. To this end diplopia must be recognized and the

double images carefully located. In all cases of moderate strabismus, with patient and intelligent effort continued for a sufficient length of time, such recognition of diplopia can be obtained, and the relations of the visual lines can be studied. Extreme cases of strabismus may first be converted into moderate cases for better observations, but in no case should a full correction be attempted until the relations of the visual lines have been carefully observed.

3d. For the accurate expression of the various deviations of strabismus more systematic terms are desirable. The terms here proposed are in harmony with those proposed for the anomalous tendencies less than strabismus.

4th. The relative position of the double images is sometimes contrary to well-known laws, and, unless the surgeon is on his guard, may be misleading. These exceptional positions of the images should lead us to the conclusion that the case is probably one of hypertropia or of disability as the result of operation. In such cases, before any considerable lateral correction is made, the hypertropia, if existing, or the disability from the displacement of the attachment of the tendon if that condition is found, should receive attention. Slight lateral correction may sometimes be required before the degree of hypertropia can be determined with sufficient accuracy to admit of a correction.

5th. The unequal tension of the two pairs of superior and inferior recti is often responsible for an apparent converging or diverging strabismus, and in many such cases cures are attempted by operations on the lateral muscles, which leave the cases in conditions worse than before the operations. The study of hypertropia, if not the most, is one of the most, important elements in the examination of any case of strabismus.

6th. The traditional "antipathy to single vision" is not a physiological fact, but a phrase expressing only the inability of the surgeon to interpret the meaning of the double vision. By relieving the tension of hypertropia, by equalizing the rotating power of corresponding lateral muscles, or making some other necessary correction, a very large proportion of such cases is either cured or resolved into cases of simple and uncomplicated strabismus.

7th. The standard operation for strabismus, by reason of its disabling effect upon the severed muscle in the performance of its office in rotating the globe of the eye, and by reason of the vastly unequal rotating power of the two corresponding muscles resulting from that operation, is an obstacle to a perfect result: and the effect of the ordinary strabismus operation must be regarded as of cosmetic rather than of optical value.

8th. Graduated tenotomies in which no tendon is disabled from performing the full required rotation of the eye, combined with tendon resection of the opposing muscle, operations if need be to be made on several muscles instead of on one, should supersede the method of raising a tendon on a hook and severing it completely.

9th. The correction of squint, with the view of obtaining perfect binocular vision throughout the whole range of vision, instead of being one of the easiest of surgical operations, is a procedure demanding the supreme ability of the accomplished observer and the highest skill of the dexterous operator.

OCULAR LEPROSY.

By Dr. E. LOPEZ, Habana.

Translated by Dr. E. C. Finlay, New York.

(*With eighteen wood-cuts.*[1])

LEPROSY is a chronic affection, localized in the tegumentary, nervous, and lymphatic systems, and which frequently attacks certain organs. It is characterized by the production of tumors, *lepromas*, or by trophic disturbances.

Leprosy has a parasitic origin. Hanson discovered in 1871 a bacillus which flourishes in leprous products, and which has the shape of a small rod, similar to that of tuberculosis, its length being about half the size of a red blood corpuscle, with pointed extremities, and which often presents small nodes in its body. The presence of this bacillus has, since its discovery, been confirmed again and again by all the authorities that have broached the subject.

Leprosy, in its evolution, assumes three distinct forms: *the tegumentary or tubercular*, the *nervous, and anæsthetic;* by whichever of these forms the process commences, sooner or later the other form will be superadded, in which case, or if both have been present from the first, we have the *mixed form—i. e.*, the anæsthetic and tubercular forms at a time.

The eye is one of the organs that most frequently are invaded by leprosy. According to Dr. Kaurin, of Norway, two thirds and even three fourths of the lepers present ocular lesions. Over half the total number of lepers at the hos-

[1] The figures, placed together at the end of the article, are fully explained in the context and in the table. pp. 426 and 427.

pital of San Lazaro, in this city (Havana), suffer from their eyes, comprising in this number only those in whom the leproma attacks the eyeball; but if we include in the ophthalmological study of this diathesis the adnexa of the eye (the eyelids), we can be sure that every leper, at some time during the course of the disease, is, or will be, an object of study for this branch of medicine.

Out of eighty patients, at present in the San Lazaro Asylum, I have found forty-three cases of leprosy localized in the organ of sight, to which have to be added two other cases observed in private practice. The number, however, would be much greater if I had taken into account the more insignificant manifestations in the lids, especially the anæsthesia of this region, which is an almost constant symptom.

Leprosy is seen in all races, as well in the pure as in the mixed. The following is the way they figure in these observations:

Whites	22
Chinese	17
Blacks	3
Mixed (mulattoes) . . .	3
Total	45

That is to say, that the ocular manifestations of leprosy are extraordinarily frequent in the Chinese race, since its numbers only make up 2 % of the total population. It is about equally frequent in the whites and mulattoes, since the latter scarcely constitute 8 % of the population. Of the whites, all were Creoles except two, who were Spaniards, and one from one of the Southern United States, but of Spanish origin; two of these came to Cuba as adults; the third has lived in this country since he was four months old. The negroes have given the least number of lepers among the patients at San Lazaro.

With respect to sex, thirty-eight were males and seven females; numbers which show a remarkable difference in liability of the two sexes.

The youngest of all these patients was ten years of age, and had no eyebrows nor eyelashes—this being the only ocular

lesion which he presented. Almost the whole of these patients acquired the disease in adult life, for although there is a moderate number of old people, it is stated in this inscription or register, that the leprosy was old, and often there were advanced lesions. The following is the relation between the ages:

Children (under fifteen years)	1
Adults	25
Old people (over fifty years)	19

Doubtlessly leprosy is rare in infancy; I have only seen two cases in over eighty patients. It is most frequent between thirty and fifty years. It is less frequent in old age: and although I have not made any special investigations in this direction, it suffices to examine the table which accompanies this paper, in which we find eight persons of fifty years of age (the limit of adult life), and five under sixty years, in order to be convinced that this essentially chronic affection must have commenced in adult life. There was only one patient (a white man) over sixty—he was sixty-nine—at San Lazaro.

Although in the column of occupations we find that most of the patients were field laborers, I do not believe that there is any marked predisposition on the part of the country people towards leprosy; but that this coincidence can be explained by the fact that until lately the Chinese and the mulattoes were employed almost solely in the fields; and that the misery of the poor classes obliges them to find refuge in charity asylums, whilst, there being no obligatory sequestration, the well-to-do lepers are generally attended to in their homes, or they seek the relief of their ills in foreign lands.

EYELIDS.

I will not detain myself to make a detailed study of the leprosy of the eyelids, which as a manifestation of a region of the skin belongs to the general clinical aspect of the disease. In order to fulfil our work in this region, it will suffice to enumerate the symptoms which the patients,

which came under our observation, presented in this region of the face.

Almost every leper will find his eyelids attacked from the beginning of his illness, either by anæsthetic patches or by tubercles, deformity of the free border due to a destruction of the hair follicles of the region. Two thirds of these patients suffered from lesions in the eyelids, visible at a simple inspection; all the more evident as they contribute to produce the characteristic physiognomy of the leper.

Anæsthesia.—The sensibility of the eyelids is lost in the form of patches which have a slightly different color, but without any apparent deformity, which can be mapped out in their whole extent by pricking the skin with the point of a pin. We find in this situation a diminution of the temperature and a destruction of the glandular elements of the tegumentary system, so that the patches are dry; this is what gives them their dull aspect.

Tubercles.—These are frequent in the lids, and if they are agglomerated together, like in leonthiasis, on account of the marked enlargement of this region, the eyes look small and sunken in the orbits. In the first case I saw a tubercle develop on the tarsus of the right inferior eyelid, presenting itself as a very small tumor, white, rounded, well defined, 3 *mm* in diameter. It was an old case of anæsthetic leprosy, which was becoming mixed. The patient of case 37 presented thick tubercles in the middle of the eyebrows, which were symmetrical, as so often occurs with leprous disorders. Lastly, the negro of case 42 (see fig.), who was a type of leonthiasis, presented in the lids, eyebrows, and between the eyebrows, thick, symmetrical tubercles, separated from each other by deep depressions, being fissured in the form of irregular curves, which gave them an aspect similar to that of the cerebral convolutions. The agglomeration of tubercles in the upper eyelid determines an incomplete ptosis, due to the inability of the levator palpebræ to overcome the resistance of too voluminous an eyelid.

Madarosis.—The loss of the eyelashes and eyebrows is one of the symptoms that appears at the commencement of

the disease, and that most calls our attention, because it gives to the physiognomy of the leper the look of a newborn infant. In contrast with this phenomenon we have the integrity of the hair of the head, which all the patients preserve in abundance, and of a natural color.

The madarosis commences in an anæsthetic patch on the naked skin, which is dry and without cicatrices, and where the generating cause has destroyed, or seriously compromised, the vitality of the hair follicles.

The hairs of the eyebrows are stopped in their growth, and fall singly, or groups lose their usual direction; and the destruction of the bulbs progresses till the region is completely hairless and smooth to the touch. If the madarosis commences in the eyelashes we observe, in addition, mechanical lesions of the eyeball, caused by the distichiasis, which is produced by the change in direction of the lashes, which is caused by the density of the leprous macule.

Case No. 28 is interesting in this respect. It refers to a white man, who had acquired leprosy when twenty-five, and who, at forty, presented the mixed form, with anæsthesia of the skin, tubercles in the face, and loss of all the phalanges of the hands and some of the feet. We noted the following: "Madarosis of the eyelashes and brows. It is incomplete in the lashes; the ciliary border remains smooth, with its natural color and aspect, without evidence of inflammation or of destructive lesions in superficial layers of the skin. The loss of eyelashes is, so far, limited to the centre of the upper lids, there being some left at the extremities, especially internally, where those that remain are black, long, and fine. In the lower lids there are only a few isolated lashes left. In the eyebrows there only remain thin, stunted, scanty hairs, but they are black. Anæsthesia of the skin. The hair of the head remains untouched, and is black, abundant, with only a few gray hairs."

The Chinaman of case 1 lost first the lashes of the lower lids, which became from the first stunted and scanty; and later on the superciliary region remained as hairless and smooth as if eyebrows never had existed.

Ectropion.—In the nervous and mixed forms of leprosy, eversion of the lower eyelid is often observed. On a leprous

macule, which, as we have already stated, presents no cicatrices nor superficial deformations, we find the gradual but progressive supervention of the deviation of the lid. The leprous agency, which has destroyed the glandular elements in their turn, attacks the terminal nervous filaments, it paralyzes the twigs of the seventh pair, and thus contributes to the palpebral eversion.

The ectropion may be observed in either of the lower lids, or in both at a time, following the evolution of the leprous plaques. At first the lower eyelid may be observed to be slightly deviated from the eyeball, and gradually we find the free border directed outward, leaving uncovered a portion of the palpebral conjunctiva.

It is known that in the paralyses *a frigore* of the orbicularis, the ectropion always follows the same type, with a greater outward deviation; and, on the other hand, senile ectropion produces an equal amount of deviation in the whole length of the eyelid. In leprosy we find no fixed type; the ectropion is subordinate to the situation of the leprous plaque; in the cases 1, 3, and 16, among others, it was limited to the inner half of the lower eyelid, but as a fact of clinical observation I must say that, in the cases that I have observed, the ectropion commenced, as a rule, in the inner half of the lid. At an advanced period the ectropion is total and complete, and we have a remarkable example of this in case 6, of a Chinaman, who presented an eversion of the tarsal cartilages of both lower lids, developed to such an extent as to expose all the mucous membrane that lined the internal surfaces of said eyelids.

Entropion.—The mulatto of case 23 presented, together with an ectropion of the lower lids, a slight inversion of the left superior eyelid. This fact, the only example I have observed, must be extremely rare, since other authors do not mention similar instances. I, however, limit myself to pointing it out, because I do not find sufficient data in my notes to confirm its dependence on leprosy.

Paralysis of the Orbicularis Palpebrarum.—The invasion and destruction by the leproma of the final nervous terminations that are distributed to this muscle, manifest

themselves, as an essential phenomenon, by the relaxation of this sphincter and by the consequent inability to close the eyelids. The cases 42, 43, and 45 are examples of orbicular paralysis. None of these patients could raise the lower eyelid, as in the act of winking. The upper lid, which scarcely covered the superior border of the cornea, as is the case in healthy persons, could not be depressed sufficiently; so that in the cases 42 and 43 it was impossible to close the palpebral fissure, notwithstanding all the efforts of the patients; but the negro of case 45, who presented less advanced lesions, could succeed in closing his eyes for a moment.

Subsequent to the paralysis there is an atrophy of the muscle. In cases 10, 42, and 43 one's attention was called to a depression of the external surface of the lower lids, which showed itself by a concavity, consecutive to a destruction of the elements of the dermis, and to an atrophy of the orbicular muscle.

To this order of lesions also belongs a slight deviation of the eyelid from the surface of the eyeball, but which was not sufficient to cause ectropion (case 10), as we have already pointed out in speaking of this leprous manifestation.

LACHRYMAL APPARATUS.

Notwithstanding the extraordinary frequency of ectropion among lepers, one does not meet the epiphora so symptomatic of this affection when it is due to another cause. This scantiness in the lachrymal secretion probably depends on the invasion of the gland by the leproma. However, I have no autopsy to confirm this surmise.

CONJUNCTIVA.

In this mucous membrane I have noted the following alterations: anæsthesia, inflammation, pterygium, and tubercles, which I will describe successively.

Anæsthesia of the conjunctiva is frequent among lepers of all classes, and is constant in the nervous form. One does not observe the least reaction on the part of the eye, on touching the conjunctiva either in its palpebral or bulbar portions,

In leprosy one meets with *conjunctivitis*, which is brought about by two causes: the one is traumatic, which we will study at once; and the other is symptomatic of the tubercle.

The anæsthesia of the conjunctiva, especially when accompanied by insensibility of the cornea, exposes the eye to continuous irritation from dust and other external agents, which come into contact with the eyeball without giving rise to any ocular reflexes, and is in this manner converted into a cause of chronic conjunctivitis, rebellious to all treatment, on account of the difficulty of protecting the eye from the pathogenic cause.

It is easy to understand that this same anæsthesia predisposes the lepers to contract acute catarrhal conjunctivitis, with a mucous or muco-purulent secretion. The chronic form, due exclusively to contact with external agents, is usually characterized by an active hyperæmia of the mucous membrane, with some photophobia, and rarely with scanty mucous secretion.

In a manner similar to the anæsthesia, does the ectropion (so frequent in lepers) act as a cause of conjunctivitis. The eversion of the lower lid exposes the ocular conjunctiva to the contact of all the irritating substances that float in the air, and which at first cause hyperæmia, and finally an inflammation of the membrane, which follows a chronic course, as is seen in all cases of ectropion, be their cause whatever it may.

The observation of lepers has confirmed the opinion which I made public in 1887, before the Academy of Medicine of Havana,[1] on the cause of pterygium. In effect, the vast field which, for these studies, is offered by the San Lazaro Hospital has allowed me to confirm that pterygium depends essentially: first, on the continuous action of external agents on the ocular conjunctiva; and secondly, on an epithelial desquamation of the cornea, or some loss of substance, on which the hypertrophied conjunctiva adheres.

The insensibility of the external ocular membranes, together with the frequency of ectropion, explains the irregular forms taken by the pterygium of the lepers.

[1] Notes on Pterygium.

Case 8 refers to a Chinaman of forty-five years of age, a field laborer, attacked by anæsthetic leprosy, who presented in his left eye two pterygia in the horizontal diameter, one internal, the other external. The same condition was present in the Chinaman of case 25, who presented two pterygia, internal and external, in the left eye, whilst the right was untouched (see fig.).

Not less interesting was the disposition of the pterygium in case 15, which refers to a Chinaman, forty years of age, whom I saw at San Lazaro Hospital, attacked by mixed leprosy, with loss of the phalanges of the hands, who, besides several other lesions, presented an internal pterygium in the right eye, and an external one in the left (figs.). This disposition is so rare, that I have never before observed it, although pterygium is so common in this country; and it would seem as if this patient had to keep his pupils turned to the right during his work, presenting the left sides of his anæsthetized conjunctivæ to the continuous irritation of external agents.

Another form of pterygium equally rare is that presented by the Chinaman of case 6 (fig.), who presented in each eye an inferior pterygium in the vertical diameter. These were fleshy, as wide at their extremities as at their bodies, without any narrowing to mark the necks. This patient presented at the same time a complete ectropion of both lower lids, and anæsthesia of the conjunctiva coinciding with anæsthesia of the skin. Thus here we find a case exemplifying better than any other the theory which I announced two years ago, attributing pterygium to an adhesion of the hypertrophied conjunctiva, to a loss of substance of the cornea, both conditions brought about by the mechanical action of external agents which come in contact with the eyeball, these not giving rise in this patient to the palpebral reflex, as much on account of the anæsthesia of the conjunctiva, as on account of the considerable ectropion which he presented.

The greater part of the pterygia observed in lepers, however, take the usual disposition on the horizontal diameter of the eye, some being so old that the patient cannot remember whether or not they were preceded by leprous manifestations.

We have *leprous tubercles* developing in the conjunctiva, in the same manner as they do in the skin. The point of election, on the eyeball, is the sclero-corneal margin. It appears in the shape of a white or slightly pinkish pimple, with a fatally progressive growth—which continues till the whole organ is lost. Other times it is situated only in the conjunctiva: such is the case in the patient of case 42, a black, of fifty-five years of age, taken at the San Lazaro Hospital for a tubercular leprosy seven years old, with characteristic leonthiasis; in this patient there was a tubercle in the bulbar conjunctiva of the left eye (fig.). It was slightly pinkish, having 7 *mm* in the vertical diameter, 4 *mm* in the horizontal, and 2 *mm* in thickness; it gradually disappeared in the external palpebral angle, whilst on the corneal side it was marked off by a well-cut, rounded border. Its consistency was somewhat soft; its surface was smooth and vascular.

CORNEA.

The cornea suffers from such important leprous manifestations, that generally the diminution of the visual power is due to the changes in this membrane. The corneal changes are frequent and varied.

The loss of sensibility is the simplest change that the corneæ of the lepers undergo. We know that in the nervous form, and in the mixed, there is a constant or almost constant anæsthesia of the skin of the lids. This skin can be touched and pricked without the patient's knowledge—*i. e.*, without giving rise to tactile or painful impressions. The cutaneous anæsthesia extends to the conjunctival mucous membrane, which also does not react on contact with foreign bodies. Finally, in the third place, anæsthesia of the cornea appears insidiously. In many cases in which the conjunctiva is more or less insensible, if we touch the cornea we get the oculo-palpebral reflex. Frequently this reflex is slow, incomplete, as tested by touching the cornea with the head of a pin; this proves the existence of a remarkable diminution of the proper sensibility of this membrane.

There are, however, numerous cases with advanced ocular lesions, in which the anæsthesia of the external membranes

of the eye is so marked and complete, that I have more than once seen flies sucking the substances which exuded from the ocular tissues, without the patient, quiet as a statue, showing, by the slightest wink, that there was any sensibility in this region. This fact is so striking, that Dr. Arango, physician to the San Lazaro Hospital, tells me that he often has had the curiosity to watch a fly for a long while quietly going over the whole surface of the eyeball without the patient's experiencing any sensation whatever.

Tubercles.—In speaking of the tubercle of the conjunctiva, we stated that these tumors, in the visual organ, most frequently developed at the sclero-corneal margin or in its proximity. We will now describe those that we have seen involving the cornea exclusively, or those that being of large size are most developed on this membrane.

On a point in the cornea, usually in its lower half, there appears a little white spot, without there being any inflammatory reaction on the part of the conjunctiva, so that it can easily be distinguished from a leucoma.

In proof of this I will call attention to case 33, of a Chinaman, fifty years of age, taken at the San Lazaro Hospital for an anæsthetic leprosy of over ten years, at present with an ataxic gait and a contraction of the second and third phalanges of both hands. In September, 1888, I diagnosed a leucoma, limited to the lower half of his left cornea, of an oval form, occupying an area of about 3 *mm*, and having a whitish color, but without the shining appearance which belongs to the cicatricial leucomas, and the surfaces of which are smooth though irregular. In March, 1889, the spot was larger and received from the conjunctiva two thick superficial blood-vessels (see fig.). The slow progress, the inflammatory aspect which it then presented, and its diffuse limits led me to the conclusion that I had to deal with a commencing tubercle and not with a leucoma as I had thought the year before. I fell into the same error on putting down as a leucoma a very small corneal leproma in case 1.

Dr. Arango confirms this way of thinking, stating that these cases, which I have just described, correspond to the first stage in the evolution of the tubercle, which can be

termed that of *infiltration* of the healthy tissue by the leprous substance. We will now see some cases of the second stage, or that of thickening and complete development ; and lastly, the third or *ulcerative* stage, brought about by the destruction of the affected tissue.

Case 17 offers us a fine example of the development of a tubercle and of its evolution during several months. A white woman, of thirty-four years of age, taken at San Lazaro for a tubercular leprosy. In February, 1888, she presented in the inferior portion of the sclero-corneal margin a white tubercle, the size of a pea, with the vertex somewhat flattened, as is seen in many staphylomata following perforations of the cornea. This tumor is hard and indolent. It is surrounded for a certain distance by a zone of keratitic infiltration identical with the leprous keratitis which we will describe further on. V = o.

In September it had increased in size, being larger than a chick-pea, the eyelid not being able to cover it on closing the eyes, its surface having now a bright red color (see figs.).

In March, 1889, the tubercle had attained enormous proportions ; it was oval-shaped in a transverse direction ; it was almost double the size of the cornea, with well developed limits, prominent, red, with superficial vascularization and irregular depressions in its upper part ; its surface had the shining appearance of porcelain ; and now its growth is more rapid on the side of the sclerotic.

Case 11, of a Chinaman, of forty-five years of age, attacked by mixed leprosy, is a case of leprous tubercle at an advanced period of development. On both corneæ there exist thick, ulcerated, fleshy masses (see figs.), covered by the inflamed conjunctiva, which gives them a red color. In the right eye it also involves the sclerotic, and is limited on the corneal side by a zone of white opacity, rendered turbid by the infiltration of leprous matter. He can distinguish large objects. In the left eye the leproma involves almost the whole cornea, and consequently sight is almost totally abolished.

Several months later these tubercles presented an uneven surface, which bled easily. The anæsthesia of the ocular surface was complete, and the foreign substances deposited thereon maintained a chronic inflammatory condition as well as suppuration, all of which contributed, with other leprous lesions and the fetid odor, to give the patient a repulsive aspect.

The mulatto of case 23 was in the same condition as this China-

man, presenting on the sclerotic and cornea of the right eye a large flattened tubercle of about 1–2 *cm* long, insensible, limited on the corneal side by a broad white halo, and covered in its whole extent by the conjunctiva, which gave it a reddish color.

It now remains for us to take up another corneal affection, the most common in the lepers. Leloir calls it leproma of the cornea; but, considering that the leprous matter produces in other membranes true inflammations: in the iris with a plastic exudation, in the conjunctiva with a mucous or purulent secretion, and at the same time bearing in mind its analogy with the heredito-syphilitic keratitis of Hutchinson, we have adopted the name of *leprous keratitis* for the affection we are describing.

The keratitis, like the other ocular disturbances, is a late manifestation of leprosy; it is only seen in advanced stages of the disease.

It appears as an isolated manifestation or as a complication in a tubercle of the eyeball.

A tubercle of the sclero-corneal margin is accompanied by a belt of leprous infiltrations of the cornea—keratitis. Frequently this zone of infiltration is directly continuous with the tubercle, forming a kind of flat border on the side of the cornea, as was seen in cases 11 and 17 (see figs.); in other cases the band of keratitis is separated from the tubercle by a zone of apparently healthy cornea. This aspect was present in case 45, a white man who had a tubercle at the extremity of the infero-external diamter of the left cornea, and opposite this tumor there was a band of keratitis 3 *mm*, wide, following the circumferential curve of the cornea, but without reaching this limit.

In the majority of cases, however, we see a badly limited opacity in any point of the corneal-border, which gradually extends along the margin of this membrane, leaving the central portion free for a long while. When this is totally invaded, as in case 18, blindness is complete.

Leprous keratitis offers at first the aspect of a leucoma. There appears on the corneal margin, or in its proximity, a whitish diffuse spot without any complicating inflammatory accompaniments on the part of the cornea, iris, or conjunc-

tiva. This opacity, which one would consider leucomatous unless being on one's guard, gradually grows larger, following in its growth the corneal margin, as we have already stated.

Its whitish color, like that of burnished glass, reminds us by its aspect of Hutchinson's keratitis, but has a somewhat more faded tint. Its borders are not well defined and gradually merge into the sound tissue.

The cornea preserves its shape, although the keratitis involve its whole extent.

The functional disorders, not present at first whilst the keratitis is partial and peripheric, become more and more accentuated as the disease progresses till there is almost complete loss of sight when the infiltration has become generalized over the whole cornea.

Leprous keratitis is frequently symmetrical, although it generally is at a different evolutionary stage in each eye.

The following are some clinical observations:

CASE 20.—A white woman, with mixed leprosy presenting in February, 1888, a small area of interstitial keratitis in the inferior extremity of the right eye, (see fig.) and only a small focus in a symmetrical point of the left eye which did not touch the margin of the cornea. In March, 1889, it had advanced quite notably, in the left eye the keratitis extended over three quarters of the corneal circumference (see figs.).

CASE 21.—Of a woman with tubercular leprosy: she showed in her left eye a keratitis occupying ¾ of the corneal circumference, in the shape of a band 3 to 4 *mm* wide, but without any alteration in the centre, so that vision was normal.

CASE 40.—Of a young man of seventeen, with mixed leprosy, who had a segment of keratitis along the external border of the cornea of the right eye.

The woman of case 18, with tubercular leprosy, presented a generalized keratitis over the whole right cornea (see fig.).

The keratitis does not, however, always commence at the corneal margin; in some rare cases it appears as a turbidity in a point more or less in the neighborhood of the visual axis. This is seen especially when a tubercle develops in the tissue proper of the cornea, around which there extends an areola of leprous infiltration.

Leprous keratitis offers a certain analogy with the heredito-syphilitic variety; but each of these has, notwithstanding, numerous distinguishing points. First of all, there is the pathological history; in the syphilitic patient the signs proper to this diathesis; and still more evidently in the leper who will present numerous lesions in the skin, since the keratitis is a late manifestation of the disease. With respect to the keratitis itself; the syphilitic is accompanied by lachrymation, conjunctival injection, most intense photophobia, whilst the leprous variety is indolent, silent, without reaction; the opacity of the syphilitic keratitis commences in the centre of the cornea and extends in all directions, always keeping the circular shape; whilst in leprosy the progress is in the inverse direction, commencing by a diffuse opacity of the margin which gradually invades the centre, either progressing in one direction or in the shape of a ring that grows broader. In the cases of the syphilitic variety which I have observed, there always has been preserved a transparent ring at the corneal margin; but in the leprous variety this membrane is finally uniformly involved. The opacity in syphilitic keratitis is white in the centre—the borders are diffuse; leprous keratitis is more colorless—turbid like unpolished glass. The syphilitic variety may go backward in its progress till a radical cure is obtained, with proper treatment; but in leprous keratitis the course is progressive, and when once generalized the patients remain irremediably blind.

It is not rare to observe in lepers *ulcers* of the cornea. The anæsthesia of this membrane favors the action of the foreign agents that wound its surface.

In five of these patients there were small ulcers of little depth, surrounded by a narrow zone of infiltration and situated principally in the centre or under the horizontal diameter of the cornea.

I frequently observed them in similar points in both corneæ; so in case 34 there existed in each eye a small ulcer, 3 *mm* in the largest diameter and situated over the horizontal diameter, inclined towards the inner side of the right eye and the outer of the left. In case 27 there were also

two small ulcers a little below the pupil, and both on the left side of the vertical diameter.

At other times they exist in only one eye. In every case they are produced: 1st, by anæsthesia of the membrane, abolishing the ocular reflex; and 2d, by the mechanical agency of foreign bodies floating in the air.

In order to terminate the description of the leprous manifestations of the cornea, we must now take up the study of its *staphyloma*, and its *atrophy*. One of the patients owed this last affection to small-pox, contracted when a child, so we will not consider him at all. We have, however, observed a case, purely leprous, in a mulatto, fifty years old (case 3), attacked by the mixed form, in which the staphyloma preceded the atrophy. In February, 1888, he presented a total staphyloma of the right cornea, which was opaque, of a conical shape, with a rounded vertex, and with an elevation of 4 *mm*, and perfectly limited to the cornea, without the least distension of the scleral limbus. V = 0.

In September of the same year the staphyloma had completely disappeared, and was replaced by an atrophied cornea, all the diameters being reduced; it was flattened, with plaits on its surface, being also in contact with the iris.

SCLEROTIC.

In describing the corneal lesions, we stated that the seat of election of the tubercle, in the eye, was the sclero-corneal margin, and transcribed several observations on account of their complication with keratitis. But usually the tubercle appears on the sclero-corneal margin case 17, (see fig.), under the form of a small whitish pimple at first, which later becomes pinkish on being covered by the conjunctiva, and it reaches much larger proportions on the side of the sclerotic; so that it can be studied with the pathological conditions of either of these membranes. In this same case 17 the tubercle had larger dimensions than the cornea, involving, in March, 1889, only its inferior third, whilst it extended over a large part of the sclerotic, and presented three depressions in the centre covered by hyperæmic conjunctiva.

In case 11 the tubercle of the right eye (fig.) occupied a third of the cornea and an equal area of the sclerotic; whilst in the left eye the tubercle, though symmetrical with the preceding in its origin, invaded the infero-external three fourths of the cornea and only a narrow band of the neighboring sclerotic (fig.).

The patient of case 15, of whom we have already spoken in describing the keratitis, presented, as a primary ocular manifestation, a tubercle, 6 *mm* in diameter in the infero-external portion (seat of election) of the sclerotic of the left eye, and which terminated at the corneal margin. The tubercle was thick, and was covered by œdematous conjunctiva, its color disappearing on pressure, and showing itself of a yellowish color for a moment.

The tubercle of the sclerotic can readily be mistaken on a superficial examination for a rheumatic episcleritis, with all the greater probability since we see lepers but rarely in private practice. The real diathetic origin can be confirmed by the finding of general leprous lesions—for example, leonthiasis,—which always precede the ocular localization; and in the appearance of the sclerotic itself, due to the greater likeness of the leproma to a tumor; by its being covered by œdematous conjunctiva, giving it a characteristic aspect; by the anæsthesia of the affected region, by its habitual infero-external position, and by its fatally progressive course. The rheumatic episcleritis, which usually presents itself in the external horizontal diameter, is painful on pressure, has the form of a depressed button, belongs to rheumatic persons, and gives way before the treatment of this diathesis.

IRIS.

Leprosy does not only attack the external ocular membranes, the conjunctiva, and the cornea; we have just described the affections of the sclerotic, and we will now pass on to the study of those of the deeper membranes.

The iris has been the seat of leprous manifestations in half the cases we are studying, at the time when I observed them, but I do not hesitate to affirm, that at an advanced period of leprosy the iris is always or almost always invaded by the leprous substance.

I have observed two manifestations in this membrane:

the *tubercle* and the *iritis*. The first of these is always complicated by the second. This reminds me that many of the iritides, which I will describe, may possibly be symptomatic of a tubercle on the posterior surface of the iris.

The tubercle may develop on any point of the iris; but probably its favorite seat is the circulus iridis major—a portion of great vascularity, in which region a nodule may form, which later will possibly invade the cornea, the sclerotic, the iris, and the ciliary processes.

Case 36, a Chinaman, forty-five years of age, attacked by tubercular leprosy about fourteen years old, with the characteristic leonthiasis, presents near the pupillary border of his left eye, on the anterior surface of the iris, two small tumors, (fig.) one to two *mm* in diameter, of a white color, in contrast with the hyperæmic iris of a reddish-yellow color, roughened on its surface, the pupil being contracted, this inflammatory condition causing pains in the eyeball.

Another case of tubercle of the iris was in a woman, sixty years old (case 21), taken at San Lazaro for a mixed leprosy with advanced lesions. Besides a peripheric keratitis of both eyes she presented at the extremity of the supero-external diameter of the iris of the right eye a small tumor, of a pyramidal shape, the vertex being bathed in the anterior chamber, and which, with Dr. Arango, I diagnosed as a tubercle of the anterior surface of the iris.

Leprous iritis follows an insidious course, essentially chronic, as are all the manifestations of this disease. It is rarely seen as the first ocular trouble; being generally preceded by palpebral deformations, pterygium, keratitis, etc.; and usually appearing without inflammatory accompaniments; at times we have a circumconical injection of the subconjunctival vessels; but in every case the iris has a darker color, is roughened, the pupil is contracted in the form of a more or less pronounced myosis, and it becomes indolent, or does not respond to light. The aqueous humor remains transparent; and if the cornea is not opaque these changes are easily demonstrable.

This inflammatory condition brings about ciliary as well as periorbital pains of little intensity, and which do not

often bother the patient; so that at times one only discovers their existence on questioning the patient.

This iritis produces an abundant plastic exudation, which is the bond of union in many posterior synechiæ.

Leprous iritis is recurrent. The periods of rest are interrupted by attacks which last one or several months.

In November, 1888, I saw at my office (case 44) a woman, fifty-three years of age, a native of the Canary Islands. She had been suffering from anæsthetic leprosy,[1] and came to consult me for some eye trouble. The night before she had had a severe pain in her right temple and eye. I noted complete anæsthesia of the conjunctiva, and a diminished sensibility of the cornea. This membrane was somewhat opaque round a small superficial ulcer, situated in its inferior half. There evidently was an iritis, with a recent plastic exudate. The iris was not clear, it was tumefied, and of a darker yellow than its fellow; the pupil was irregularly contracted.

In both eyes one could observe posterior synechiæ and deposits of pigment on the cristalline lenses, as a sign of old irites. Indeed the right eye had been attacked twice; two months later there was an attack in the left eye, and finally, at the time of observation, a month after the last attack, there appeared the present one, with its violent onset and intense pain.

I prescribed atropine drops, and calming lotions of hyoscyamus.

Due to the effect of these drugs, on the second day, we see the pupil contracted, deformed, with three partial globular dilatations, all the iris being turbid and thickened. In the left eye the pupil is dilated and round; on the centre of the cristalline lens one sees a ring of pigment, due to old adhesions, which, if we are to believe the patient, tore of their own accord, since she states that she never had had her eyes treated before. $V = \frac{1}{6}$.

It is useless to detail all the cases of leprous iritis that I have seen; all were similar to each other, the differences lying in the presence or absence of conjunctival injection, in the intensity of the pain, etc. The first symptom that reveals us the presence of the iritis, and which may be the

[1] This woman, of healthy parents, came to Cuba when four months old. At the menopause she had during two months repeated hæmoptyses, without any cough or tubercular affection. At this period, she states, commenced the anæsthetic leprosy.

only appreciable one of a hyperæmia of the iris, is myosis. The change in the color is not so easily made out. When the iritis is intense it is accompanied by lachrymation, photophobia, but these two symptoms are rarely observed as functional disturbances; this iritis determines a variable diminution of sight.

Several of the patients that I examined presented posterior synechiæ in one or both eyes, without a trace of inflammation. These patients were then in the quiescent periods, of five or six months' duration, which so frequently are observed in leprous iritides.

Among the lepers that I examined, the patient of case 40, a mulatto, seventeen years old, for eight years had been suffering from mixed leprosy, with contractions and loss of the phalanges of the fingers; presented an infero-external coloboma in both irides. On the pupillary margin of the right eye there were some points as shining as silver. The pupils were immovable. $V < n$. These colobomas, probably congenital, and which I do not believe had the slightest relationship to leprosy, were complete, occupying the space between the circumference and margin of the iris. When first examined there was no leprous affection of the eyes whatever. Several months later there appeared, at the external border of the right eye, the specific keratitis with chemosis of the adjacent conjunctiva.

CRYSTALLINE LENS.

Of the two patients with the alterations of the lens whom I have observed, the first (case 10) presented one of the most complete pictures of ocular disturbances of a leprous origin. It refers to a Chinaman, sixty years of age, taken at San Lazaro for a mixed leprosy, with mutilation of the extremities. Behold the enumeration of his ocular disturbances:

In the superciliary and palpebral regions: *anæsthesia* which extended to the proper tunics of the eye; incomplete *madarosis* of the eyebrows and lashes; and *ectropion*, which, though slight, prevented the patient from closing the eyes, due to the lower lids not moving in this act. With respect to the conjunctiva, there was a general *conjunctivitis*, more intense in the bulbar portion.

In February, 1888, besides these symptoms, he presented a *sclero-choroiditis* in both eyes, with brownish-colored patches in the equatorial region, and multiple and small leucomata scattered over the corneæ. This clinical picture reveals a glaucomatous affection, probably due to a leproma of the superior ciliary region, where there was most sclero-choroiditis. $T > n$; $V = o$.

In September white spots were observed on the inferior margins of both corneæ. In the right eye there was a chronic iritis like that already described. The anterior chamber was very deep, and the iris was movable from before backward, due to a complete dislocation of the lens. In the left eye there was a punctiform pupil, due to old exudates of old iritides, which caused a pupillary obstruction.

In March, 1889, the pupil of the right eye was dilated, the iris tremulous, the anterior chamber deep ; through the pupil one could see a piece of thickened or white capsule floating in the vitreous — aphakia.

So that, in this patient, it is probable that a ciliary tubercle first attacked the suspensory ligament of the lens, causing first its dislocation and then its complete destruction.

The negro woman, of case 22, taken at San Lazaro for tubercular leprosy, presented in her left eye a *luxation of the lens*, the superior border of which was directed downward and backward, due to a rupture of the superior suspensory ligament. The lens was the seat of a hard, complete *cataract*, of a mother-of-pearl color, on which could be observed radiating striæ. On making the eye move, one can observe the changes in position in an antero-posterior direction of the lens. When the patient looks up the upper third of the pupil remains free and black. The sight is, however, so diminished that the patient only distinguishes objects.

We see, therefore, that the changes in the lenses of lepers are secondary to the invasion of the ciliary region by the leprous agent, isolating it by destroying the zonula, it losing its transparency after its dislocation, or disappearing completely, due to changes in its nutrition.

INTERNAL MEMBRANES.

The choroid and retina are less liable to be attacked by leprosy than the other parts of the eyes. When one of

these patients complains of a loss of sight, there is generally some lesion of the cornea or iris to account for it. Nevertheless, the eye does at times suffer functional disturbances in the absence of all lesion in the exposed membranes.

I could not examine well the fundus of the patient of case 1, on account of opacities of the vitreous.

We have just seen, in case 10, an *anterior schlero-choroiditis* of leprous origin.

I do not doubt that, at an advanced stage of ocular lesions, the retina and choroid are also involved by leprosy, but in the cases that I have examined, when the ophthalmoscopical examination was possible, I have not discovered any lesion of these deep regions.

FUNCTIONAL DISTURBANCES.

Dr. Arango confirms the frequency of *hemeralopia* among lepers. An orderly at San Lazaro, for example, who during the day can see perfectly, is surrounded by utter darkness when night comes on, without there ever having been an ocular lesion. The hemeralopia appears at certain ill-determined epochs, and generally in several patients at a time. This, therefore, offers some analogy to what is observed in prisons, camps, etc., or wherever many persons are agglomerated together, without attention to hygiene, there being an insufficient alimentation; in a word, it is dependent on the anæmia brought about by hospital life. I remember, when I attended the clinics at the San Felipe y Santiago Hospital in this city, the frequency of hemeralopia in the prison department, which was occupied by men, weakened by excessive labor, and deprived of rest and of sufficiently nourishing food. But the patients at San Lazaro are in a totally different condition; the building is situated on the sea-side, it is bathed by the breezes, it is provided with gardens and wide galleries; and it is certainly to be commended for its excellent hygienic conditions. Each patient has a separate cell, and has no other work but taking care of himself. We must attribute the hemeralopia to the leprous anæmia, which is observed from the first in all those suffering from this disease.

CASES OF

No.	Race.	Sex.	Age.	Profession.	Form of Leprosy.	General Disorders.	Ocular	
							Eye Involved.	Eyelids.
1	Ch.	M.	40	Field-laborer.	Anæsthetic.	Contract'ns of the phalanges.	R. L.	Ectropion, Madarosis.
2	W.	M.	60	Field-laborer.	Mixed.	Tubercles, Anæsthesia.	R. L.	Madarosis.
3	M.	M.	50	Field-laborer.	Mixed.	—	R. L.	Ectropion, Madarosis.
4	W.	M.	45	—	Mixed.	—	R. L.	Madarosis.
5	W.	M.	45	—	Mixed.	—	L.	—
6	Ch.	M.	37	—	Anæsthetic.	Loss of the hands and phalanges of the toes.	R. L.	Ectropion, Madarosis.
7	Ch.	M.	50	Field-laborer.	Mixed.	—	R. L.	Tubercle, Madarosis.
8	Ch.	M.	45	Field-laborer.	Anæsthetic.	—	R. L.	Madarosis.
9	W.	M.	50	Field-laborer.	Mixed.	—	R. L.	—
10	Ch.	M.	60	Field-laborer.	Mixed.	Loss of phalanges of hand.	R. L.	Ectropion, Madarosis.
11	Ch.	M.	45	—	Mixed.	—	R. L.	Ectropion, Madarosis.
12	M.	M.	50	—	Anæsthetic.	—	R. L.	Ectropion.
13	Ch.	M.	45	—	Mixed.	—	R. L.	—
14	W.	M.	10	—	Mixed.	—	R. L.	Madarosis.
15	Ch.	M.	40	—	Mixed.	Loss of phalanges of hand.	R. L.	Madarosis.
16	Ch.	M.	40	Field-laborer.	Anæsthetic.	—	R. L.	Ectropion.
17	W.	F.	34	—	Tubercular.	Tubercles of the skin.	R. L.	—
18	W.	F.	41	—	Tubercular.	Tubercles of the skin.	R. L.	—
19	W.	F.	60	—	Tubercular.	—	R. L.	—
20	W.	F.	60	—	Mixed.	Advanced lesions.	R. L.	Tubercles.
21	W.	F.	55	—	Tubercular.	—	R. L.	—
22	N.	F.	60	Field-laborer.	Tubercular.	Tubercles of the skin.	R. L.	—
23	M.	M.	40	—	Mixed.	General anæsthesia.	R. L.	Madarosis, Ectropion, Entropion.
24	W.	M.	69	—	Anæsthetic.	Loss of phalanges.	L.	Ectropion.
25	Ch.	M.	40	Field-laborer.	Anæsthetic.	—	R. L.	Madarosis, Ectropion.
26	Ch.	M.	50	Field-laborer.	Anæsthetic.	—	R. L.	—
27	Ch.	M.	56	Field-laborer.	Anæsthetic.	Multiple mutilations.	R. L.	—
28	W.	M.	40	—	Mixed.	Loss of phalanges.	R. L.	Madarosis.
29	M.	M.	34	Clerk.	Mixed.	Anæsthesia, Tubercles on the face.	R. L.	Madarosis.
30	Ch.	M.	48	Field-laborer.	Anæsthetic.	Multiple mutilations.	R. L.	Madarosis.
31	Ch.	M.	40	Field-laborer.	Anæsthetic.	—	R. L.	Madarosis.
32	Ch.	M.	50	—	Anæsthetic.	Loss of phalanges.	R. L.	Madarosis.
33	Ch.	M.	50	—	Anæsthetic.	Ataxic gait, Loss of 2d and 3d phalanges of hands.	R. L.	Madarosis.
34	M.	M.	40	Field-laborer.	Mixed.	—	R. L.	Madarosis.
35	W.	M.	35	—	Mixed.	—	R. L.	Madarosis.
36	Ch.	M.	45	—	Tubercular.	Leonthiasis.	R. L.	Madarosis.
37	W.	M.	37	—	Mixed.	—	R. L.	Madarosis.
38	W.	M.	37	—	Mixed.	—	R. L.	Madarosis.
39	M.	M.	50	—	Anæsthetic.	Contraction of the phalanges of the hands.	R. L.	Orbicular atrophy.
40	M.	M.	17	—	Mixed.	Phalangeal mutilations.	R. L.	Madarosis, Ectropion.
41	W.	M.	30	—	Tubercular.	Destruction of nose.	R. L.	Tubercles, Orbicular atrophy.
42	N.	M.	55	Field-laborer.	Tubercular.	Leonthiasis.	R. L.	Tubercles.
43	N.	M.	35	—	Anæsthetic.	Loss of phalanges.	R. L.	Madarosis, Orbicular atrophy.
44	W.	F.	53	At home.	Anæsthetic.	General Anæsthesia.	R. L.	Madarosis.
45	W.	M.	27	Armorer.	Tubercular.	—	L.	—

OCULAR LEPROSY.

DISORDERS.

Conjunctiva.	Cornea and Sclerotic.	Iris.	Deep Membranes.	Cristalline Lens.	Sight.
—	—	Iritis.	—	—	—
—	Keratitis.	—	—	—	—
Anæsthesia.	Staphyloma, Consecutive atrophy.	Posterior synechia.	—	—	—
—	—	—	—	—	—
—	Atrophy.	—	—	—	—
Anæsthesia, Pterygium.	—	—	—	—	—
Pterygium.	—	Iritis.	—	Aphakia.	—
Pterygium.	—	—	—	—	—
Pterygium.	—	—	—	—	—
Conjunctivitis.	Keratitis.	Iritis.	Sclero-choroid-itis.	Aphakia.	—
—	Tubercle.	—	—	—	—
—	Keratitis.	Iritis.	—	—	—
—	Keratitis.	—	—	—	—
—	—	—	—	—	—
Pterygium.	—	Iritis.	—	—	—
—	—	Synechia.	—	—	—
—	Tubercle.	—	—	—	V = o.
—	Keratitis.	—	—	—	V = o.
—	Atrophy, Keratitis.	—	—	—	V = o.
—	Keratitis.	Tubercle.	—	—	—
—	Ulcers, Keratitis.	—	—	—	—
—	Keratitis.	—	—	Dislocation, Cataract.	V = o.
Tubercle.	Tubercle.	Anterior synechia.	—	—	Diminution.
Anæsthesia.	Anæsthesia, Keratitis.	—	—	—	—
Conjunctivitis, Pterygium, Anæthesia.	Anæsthesia, Ulcers, Keratitis.	Iritis.	—	—	—
Pterygum, Anæsthesia.	Anæsthesia.	—	—	—	—
Anæsthesia.	Ulcers.	Synechiæ.	—	—	Diminution.
Anæsthesia.	—	—	—	—	—
—	—	Iritis.	—	—	—
Anæsthesia.	—	—	—	—	—
—	—	—	—	—	—
Pterygion.	—	—	—	—	—
Conjunctivitis.	Keratitis.	—	—	—	Diminution.
Pterygium. Anæsthesia.	Ulcers.	Iritis.	—	—	—
—	—	Myosis.	—	—	—
—	—	Tubercle, Iritis.	—	—	Diminution.
—	—	Posterior synechia.	—	—	Diminution.
—	—	Myosis.	—	—	Vertigo, Diminution.
—	—	Myosis.	—	—	—
Chemosis.	Keratitis.	Coloboma.	—	—	Diminution.
—	—	—	—	—	—
Tubercle.	Keratitis.	Iritis.	—	—	Diminution.
—	—	—	—	—	—
Anæsthesia.	Ulcer, Keratitis.	Iritis.	—	—	½
—	Tubercle, Keratitis.	—	—	—	—

A leper of San Lazaro (case 38), thirty-seven years old, attacked by mixed leprosy, complained of *ocular vertigo.* This patient, the only one that complained of symptoms of this nature, presented myosis with congestion of the iris, and had V < *n* in the left eye. He experienced the sensation of tremor and movement of the surrounding objects; his gait being uncertain, due to a false appreciation of the distance of the ground.

The leprous manifestations generally commence in superficial regions, invading the deeper tissues later; so that *sight* is, as a rule, unaltered till visible lesions make their appearance.

The keratitides and iritides are the most frequent causes of loss of sight among lepers. Whilst the keratitis has the annular form and is peripheric, the acuteness of sight will be diminished; but as the opacity increases, so as to gradually involve the centre, sight gradually diminishes in the same proportion till it is abolished. The same result is obtained by the iritides; a first attack with partial synechiæ, as is usually the case, weakens the visual power by the narrowing and irregularity of the pupil, and by the deposit of pigment on the lens on the tearing of the synechiæ. In subsequent attacks the greater congestion of the iris, the abundance of the plastic lymph-exudate, obstruct the pupil and convert the iris into a screen, which prevents the access of luminous rays to the retina. In this condition sight is reduced to mere perception of light.

At a more advanced stage, and which is quite frequent, the patient lives in complete darkness—without being able to distinguish day from night, and only recognizing sunlight by the burning sensation of the skin. In order that these effects be produced, it is necessary that the leproma invade or destroy even the most sensible points of the retina, possibly the optic nerve itself. I believe the choroid to be the means of transport for the infecting, destructive substance in these cases.

In short, the leper enjoys normal vision for a more or less long time. When the eyes commence to be affected the sight diminishes gradually, in proportion to the stage to which the lesions have advanced, till it is entirely abolished. V = 0—in a definite and irremediable manner.

THE EYE AS A WHOLE.

The lepers lose the brightness and expression of their look, as the disease has already made them lose their strength of character. Thus Leloir, in speaking of the facial neuralgiæ, so frequent among lepers, expresses himself in these terms: "When the neuralgic pains of the face are concentrated especially around the eyes and root of the nose, and have lasted a more or less long time, the conjunctivæ become slightly injected, the look is dull, and the eyes take a melancholic expression." This is, in effect, the first symptom which calls attention to the eyes of the lepers. During the course of the disease appear all the various manifestations in the different membranes of the eye which we have mentioned. At an advanced stage of the disease the keratitis is followed by atrophy of the cornea, the pupiliary obstruction terminates by an atrophy of the iris; the conjunctiva is the seat of xerosis; and lastly, the tubercle, with its slowly invading progress, involves all the membranes, destroys all the tissues, ulcerates and converts the eye into bloody tumor, which causes total atrophy of the organ, and which, at the end of its evolution, leaves only a stump lost in the depth of the orbit.

TREATMENT.

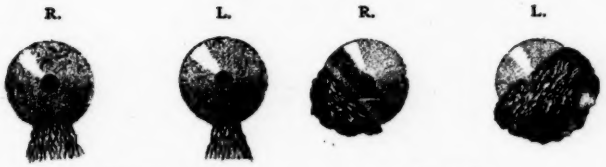
The physician must before every thing try and prevent the extension of the leprosy to the organ of sight. One must take into consideration the fatal influence of the anæsthesia in the preservation of the eyeball. We have dwelled on the conjunctivitis, pterygium, and corneal ulcers, which are produced by the mechanical action of external agents floating in the air. To avoid these agents, by placing the patients in protected rooms, covering their eyes with eye-glasses, isolating them as much as possible, ought to be the first object of our attention.

As soon as there is any ectropion, it ought to be operated by one of the classical procedures. One ought to resort without fear to surgical measures, as the facility with which wounds in lepers heal is well known. Not long ago Dr. Montalvo operated a leper for cataract with success.

It seems impossible to arrest the growth of a leproma that has invaded the eyeball, but I have no doubt that the igneous cauterization of the tubercle can at least retard its progress.

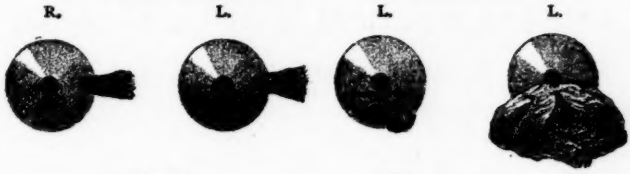
The local medicinal treatment should consist in lotions of boric acid (3 %) or of bichloride of mercury (1 : 5,000), repeated several times a day in order to keep the parts clean. If there are corneal ulcers, it is convenient to use ointments, of the yellow oxide of mercury 0.30 gr., or of boric acid 1.00 gr. to ten of vaseline. For iritides we use atropine $\frac{0.05}{10.00}$, till we get mydriasis, which is kept up by the use of a less concentrated solution.

In a word, so as not to repeat treatments which are already known, each affection ought to be treated by the usual measures employed for similar diseases; having before us the fact that we only obtain more or less lasting improvements; but in no way a radical cure, since up to date we know of no agent that is to leprosy what mercury is to syphilis.



(Case 6.)
(Inferior pterygia in ectropion.)

(Case 11.)
(Tubercles of the cornea.)



(Case 15.)
(Int. pterygium of the R. E.; ext. of the L. E.)

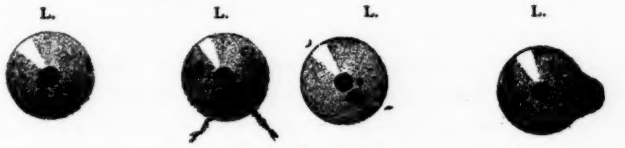
1888. 1889.
(Case 17.)
(Tubercle of the eyeball.)

(Case 18.)
(Leprous keratitis.)

1888. 1889.
(Case 20.)
(Leprous keratitis.)

(Case 20.)
(Leprous keratitis and Tubercle of the iris.)

(Case 25.)
(Int. and ext. pterygium of the L. E.)



1888. 1889.
(Case 33.)
(Tubercle of the cornea.)

(Case 36.)
(Tubercles of the iris.)

(Case 42.)
(Tubercle of the conjunctiva.)

DRAWINGS REFERRED TO IN THE TEXT.

HELPS IN PRACTICAL OPHTHALMIC WORK.

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(*With three wood engravings.*)

I.—AN IMPROVEMENT IN BIFOCAL LENSES.

IN the *Medical and Surgical Reporter* of Nov. 3, 1888, I called attention to an improved method that I had devised of making bifocal lenses. I now wish to bring it more directly to the notice of ophthalmologists, to give the result of my experience, and to add my hearty approval of the plan. This seems all the more necessary since some opticians have tried to make the spectacles without a proper conception either of the objects designed to be secured, or of the best method of construction.

The general appearance of the lens is shown in the annexed cut. The size of the presbyopic segment may be slightly increased or decreased, but the general shape and relative proportions must be retained. The distance-lens should be a little larger than for unifocal lenses, and the (simple plus spherical) presbyopic segment must be ground to the thinness of a watch-crystal—especially at its upper edge,—and attached to the inner surface of the distance-lens by Canada balsam. There is thus no prismatic effect at the junction of the presbyopic segment which when the spectacle is upon the face is quite invisible either to others or to the patient. No rims are required, and the lightness and gracefulness of the spectacles make them pleasing to all and especially to ladies.

There are two reasons why I have found this device commendable.

1. Speaking medically, I have found it of the greatest benefit to the patient to have eye-strain relieved at *all* times. Patients who use two different pairs of spectacles are continually using their distance-lenses for near work, or *vice versa*, and, indeed, are frequently entirely without one or the other pair owing to the fact of their having broken or mislaid them. The eyes are nearly as much strained at meals as for reading, and even with the greatest care, which

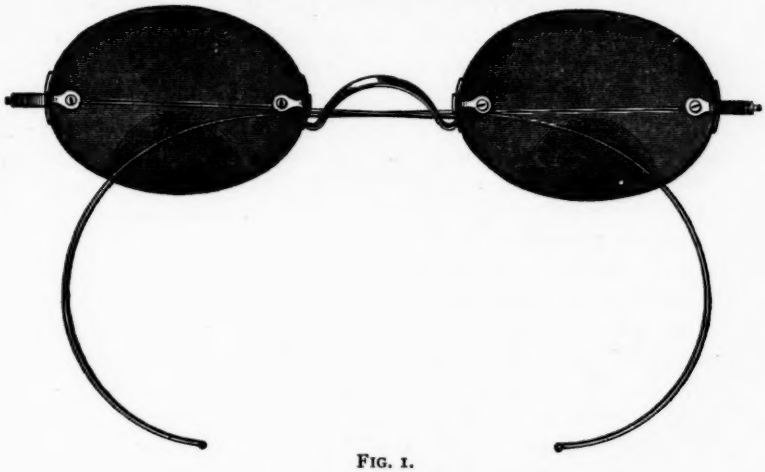

FIG. 1.

is unusual, eye-power is constantly required that by this device is saved. Again, with all other styles of bifocal or Franklin lenses (as we should perhaps call them), the patient cannot see the ground at or in front of his feet, and even if walking with extreme care, is liable to make missteps. It is a highly important advantage of the improved lens that a slight inclination of the head, that becomes unconscious and instinctive in a week or two, enables the patient to see the floor at his feet through the distance-lens.

2. Annoyance and discomfort are spared the patient. Two pairs of glasses are fused into one, and that is worn all the time. The vexation caused by carrying and always

changing two pairs is avoided, and the expense of breakages is spared. Neither should it be forgotten that the elegance and sightliness of this lens as compared to other styles are not unimportant.

I have now prescribed these spectacles some sixty times with four failures. The failures indicate the limitations that should be considered to their universal use, and have led me to these cautions: 1. Do not advise them for the extremely stupid and headstrong, who will not try to learn their use, and who prefer to magnify minor disadvantages and ignore the far greater advantages. 2. Do not prescribe them for a person whose avocation requires a large near field of vision. One of my failures was the case of a compositor, as to whose calling I blunderingly failed to inquire. Of course he could not see all parts of his case without too great movement of the head. He still uses his bifocals for street and home use. Another case was an artist who required a view of the *ensemble* of pictures. The rest of my patients are most profuse in their praises,—none more so than ladies and professional men, especially physicians.

It may be well to add that of the three elements required for their successful application—scientific refraction, skilled manufacture, and accurate intelligent adjustment to the eyes and face,—the last, in these spectacles, is of exceptional importance. Many opticians are now manufacturing them, and all tell me the demand is increasing. The device has of course been given to the profession, and all opticians are privileged to manufacture.[1]

II.—OBVIATION OF THE LIGHT-CIRCLE ABOUT LENSES.

This ingenious plan was devised by my friend, Dr. J. Neely Rhoads, of Philadelphia, and consists simply in bevelling the edge of the lens all around at such an angle that it shall form a plane with a line drawn from the pupil. It is a small disadvantage that this serves slightly to exaggerate the light-reflex as seen by others than the wearer. Many

[1] It is, however, only fair to add that to the experimentation, skill, and persistent interest of Messrs. Wall and Ochs, Philadelphia, are due the mechanical success and introduction of the same to general use.

will not care for this, thinking that their spectacles are for their own comfort, not for their friends' pleasure. Indeed, in certain defects and to certain sensitive eyes, the ordinary reflection is so intolerable, and especially at night, that its avoidance becomes of therapeutic importance. The above-described plan is absolutely and beautifully effective. The edge of the lens becomes entirely invisible to the wearer,—a delightful relief, especially by artificial light. After considerable experimentation I have found that it is useless to try any pigmentation of the bevelled edge to avoid the appearance of the light-ring to the spectator. The edge must not be polished but left in a state intermediate between that of ground glass and that of a lustrous polish. Fig. 2 shows the appearance of the lens in position as seen from the side and slightly from behind.

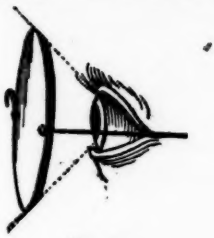

FIG. 2.

III.—A NEW DEVICE FOR MEASURING ASTIGMATISM.

This has in my office been a most satisfactory means of:

1. Proving with the utmost quickness the existence of astigmatism, even of small amounts, and in eyes with functional accommodation.

2. Proving with exceptional precision the exact axis of astigmatism. (There are many more axes at 80°, 85°, 95°, or 100° than is commonly supposed.)

3. Saving wearisome repetitions of questions and the annoyance of imperfect understandings and delays in answering on the part of the patient.

4. Estimating the total ametropia by crossed cylinders.

The mechanism consists of a rigid framework that mounts a card about two feet square, containing circle-wise the

meridional numbers every ten or fifteen degrees. This card is pierced in the centre by a revolving shaft upon which is mounted a disc, with astigmatic lines all in one meridian, about eight inches in total width and fifteen inches in length. The central line is used as a pointer, indicating the axis by any number opposite which it may be revolved. This external disc is revolved by an endless wire or cord

FIG. 3.

wound about the shaft behind the disc, and by double pulleys extending along the surbase of the room to the left of the refraction-case opposite, where a mirror may be placed in front of the physician in such a way as to show him the position of the disc as he rotates it by means of the cord.[1] It is noteworthy how quickly and easily the patient, even in the smallest degrees of astigmatism, discovers the exact axis by means of the clearness or fading of the lines. While

[1] The disc may also be revolved by an electrical apparatus.

slowly rotating the disc, the single question to ask is the designation of the position where the lines become most clear and black, and where they are most blurred or gray. The location of the best meridian being agreed upon, it only remains to bring it to perfect definition by the test lenses, then rotate the disc to the opposite meridian and bring that out in the same way. In cases of amblyopia and irregular astigmatism I consider this instrument by all odds the speediest and most accurate means of differential diagnosis. The sketch, fig. 3, annexed shows in a rough way the appearance of the mechanism.[1]

[1] Messrs. Wall and Ochs will answer correspondence in reference to the mechanical details.

TWO CASES OF VERY PRONOUNCED DISSEMINATE CHOROIDITIS WITH PRESERVATION OF NORMAL ACUTENESS OF VISION.

By ROBERT L. RANDOLPH, M.D.,

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THE two cases whose histories are recorded here came under my observation a few months ago, and from the rather unusual features presented to examination, I have deemed them subjects worthy of special report.

CASE I.—H. Fechtner, twenty-four years old. Five years ago was treated for eye trouble in New York. His vision at that time was bad, but he recovered his sight entirely. Not long afterward he entered one of the New York hospitals as night orderly, and there remained for several years. Came to Baltimore a few months ago. He complains now of pain in the temples, which has been more or less constant for the past year. Sees floating specks in front of his eyes when he looks at any thing upon a white background; particularly is this the case when he is reading. He looks strong and healthy, and denies syphilitic taint. Eyes light blue. Pupils respond perfectly. Nothing indeed abnormal presented itself to external examination. Color-sense perfect, so also field of vision in both eyes. Vision in both eyes $\frac{20}{25}$, in right eye almost $\frac{20}{15}$. Reads Jaeger No. 1 with ease and rejects glasses. No astigmatism. The ophthalmoscope revealed transparent media, and absolutely no appearance of floating bodies in the vitreous. Both fundi were the seat of positive and—in the light of such good vision—of remarkable changes. The entire fundus of each eye was covered with large and small white patches dotted with points or specks of black pigment. The accompany-

ing diagram is a correct likeness of the fundus of the left eye. The fundus of the right eye differed in no respect except that the changes were less pronounced in the macula region.

The optic nerve was of normal size and slightly oval in shape, and its outer edge was bordered with a narrow and delicately formed pigment ring. The color of the papilla was yellowish-red on its nasal half, fading off into a whitish hue on its temporal side. The central blood-vessels and the retina presented not the slightest pathological change. The fundus however in the choroidal region, which is normally colored a golden red and presents a granular appearance, was everywhere dotted with yellowish-white and black and white spots of various sizes and shapes. These spots appeared to be in the same plane, and moreover to be imbedded in the deeper layers of the choroid. The smallest of the spots looked like white granules tipped with fine black points. The larger spots had a yellowish-red lustre, and were generally bordered with a deep black pigment ring. The two largest patches, with the exception of several pigment spots in their centres, were perfectly white, and in size had a diameter about twice that of the papilla. The other spots of this class had a prevailing diameter of about half that of the papilla, and preserved either the oblong or oval shape. The smaller spots were generally perfectly white, and had usually the annular form, with sharply cut borders, presenting much the same appearance as is seen in the *choroiditis areolaris* of Förster. On the nasal side of the optic nerve there was a large pigment spot, the length of which was nearly twice the diameter of the papilla. This spot, from the plane in which it was located, its peculiar form and deep black color, recalled the pigment

changes found in retinitis pigmentosa. The spot was undoubtedly situated in a plane somewhat anterior to that of its fellows. The portions of the fundus between the spots presented nothing worthy of note, except that here and there one observed slight discolorations which might possibly be the forerunners of the more pronounced changes pictured in the diagram.

CASE 2.—The following case came to the eye clinic of the Johns Hopkins Hospital Dispensary a few weeks ago, a case which in its main features closely resembled the one just described.

Dora Hartman, thirty-three years old, married, and has six children. No miscarriages. At times has suffered with pains in her knees and elbows. Has lost much of her hair.

Lately she has been subject to almost constant headache and *mouches volantes*. Denies syphilis. Eyes hazel, pupillary reaction perfect, and externally nothing abnormal. Media transparent. L. E. vision $\frac{20}{20}$. R. E. vision $\frac{20}{200}$. Reads Jaeger No. 1. The fundus of the right eye gave a pale reflex as though there were general thinning of the choroid. Changes most marked in the vicinity of the macula, which latter region of the fundus was covered with large black patches, which became smaller as they neared the periphery, and which assumed in this division of the fundus the annular shape with atrophic centres, just as is seen in case 1. The blood-vessels as regards size presented nothing noteworthy, but in their relation to the pigment spots there was much to suggest what we see in retinitis pigmentosa. As is common in this latter disease, so here were the blood-vessels in their entire course beset with these pigment changes. At points a vessel would disappear from view beneath a patch, but in by far the majority of cases the course of the vessels could be clearly traced as they passed over the diseased areas. The vision in this eye was $\frac{20}{200}$. The left eye presented changes resembling very closely those pictured in case 1. The vision was $\frac{20}{20}$.

It is difficult, nay impossible to say, whether the process began in the choroid or in the retina, or whether it started in both at the same time. Certain it is that if the retina was to any extent involved in the beginning, the inflammation must have stopped and receded early in the history of the trouble, or at least it must have only attacked the connective tissue and pigment epithelium elements, and left intact the nervous elements. The presence of pigment

accumulations in the retina was clearly apparent, but the visual disturbances of retinitis pigmentosa were quite as clearly absent.

Striking were the changes in the choroid, the changes showing themselves by atrophy of the choroidal stroma, and the appearance beneath of the white sclera. The round white spots with their pigmented borders, strongly suggested the pathological process peculiar to choroiditis areolaris. The stages of this latter disease are as follows: First, a pigment spot, then a gradual fading away of the pigment in the centre of the spot, until all that is left of the original spot is a black ring with a perfectly white centre. The last stage of this local process is disappearance of the ring, or in other words complete atrophy of the remainder of the pigment, leaving behind a round white spot. The fundus of each eye presented the appearance of almost complete disorganization, yet the perfect vision indicated unimpaired functions, the only exception to this being the right eye of case 2. In this latter case the ophthalmoscope failed to reveal why the vision in the right eye was only $\frac{20}{200}$, the fundus of this eye being exactly like that of the fellow eye.

This, though, is not infrequently the history of choroiditis disseminata, namely, two eyes functioning alike and presenting the same objective appearance, and suddenly loss of vision in one eye without visible change in the objective condition of the latter. No doubt the lesion could be disclosed through the microscope.

As I said before, it was impossible to establish a syphilitic origin of the disease in either case, though a course of treatment under the biniodide of mercury produced marked improvement in both cases, as far as the headache and *mouches volantes* were concerned. The vision in case 2 has never changed. Such cases are at least instructive, in that they show that the fundus of an eye may be the seat of positive pathological changes, and yet perform its functions as perfectly, to all appearances, as does a normal fundus. It is an interesting problem then to solve, namely, what part do those elements which are present in

a normal fundus, and which in these two and in similar cases have become diseased and, in some portions of the fundus have entirely disappeared, what part they play in the physiology of vision. Hardly a week passes that I do not see a case of choroiditis with the objective condition far less pronounced than in either of the two cases just reported, but which is almost invariably attended with serious impairment of vision.

That low grades of choroiditis disseminata do occur when the vision is little if any thing affected, is a matter of fact, and can be accounted for on the ground that the dislodgement and compression of the percipient elements of the retina are limited to small spots, and that too, most frequently in the periphery, and so long as this is the case, and the conducting fibres of the retina preserve their integrity, the vision will not be noticeably affected.

Almost always the existence of large atrophic areas, as in cases 1 and 2, indicates the existence of scotomata, but with the exception of a slightly impaired field for red in the right eye of case 2 there was no break in the visual field in either case, and this absence of visual disturbances can only be explained by supposing that the percipient elements of the retina escaped the diseased process.

Such cases, then, are full of interest and instruction, because they show that the most important region of the eye may present to the ophthalmoscope the appearance of complete disorganization, yet when the eye comes to do its allotted work no fault can be found. And this fact in itself is valuable, and should always be considered in giving the prognosis of inflammation of the choroid when we are disposed—as is frequently the case—to be guided by the ophthalmoscopic condition.

ON THE DETERMINATION OF REFRACTION WITH THE ILLUMINATION TEST.

By Dr. CARL SCHWEIGGER, of Berlin.

Translated by Dr. James A. Spalding, Portland, Me.

I THINK that the method of determining the refraction suggested by Cuignet,[1] and particularly worked out by Chibret,[2] under the titles of keratoscopy, retinoscopy, pupilloscopy, etc., ought to be summed up once more in brief in these Archives, for the chief reason that it has found but few adherents and cultivators in Germany. The most suitable German phrase for this method of investigation would be "the illumination test," for its essential purpose is to determine the optical value of the displacement of the illuminated field in the fundus of the eye by revolving the mirror upon its axis. The numerous papers that have appeared at times in foreign periodicals have so thoroughly exhausted the subject that there is really nothing left to be said, except in a practical point of view. Therefore the only question upon which we as Germans have to lay any stress is, whether we can with this method measure the refraction of the eye as accurately as with the refracting ophthalmoscope.

Every objective determination of refraction is based upon the law of the conjugate focal distances. The illuminated fundus of the eye invariably projects its image precisely upon the spot for which the eye is optically adjusted. In the examination in the erect image the examiner under-

[1] Kératoscopie; *Rec. d'Ophthal.*, 1873, p. 14.
[2] Skiascopie; *Arch. d'Ophth.*, T. vi., p. 146.

takes the task of throwing into his far point, by means of suitable lenses, the *virtual* image of the fundus of the examined eye, in which act the refraction and accommodation of his own eye may cause some difficulties. But in the illumination test, on the contrary, the problem is to place at the same far point, by suitable correcting glasses the *real* image of the fundus, unless it already lies, as in myopia of moderate degree, at between 20 to 40 *cm.* The examination in the erect image—omitting the fact that in many cases (*e. g.*, astigmatism) no distinct images of the fundus or retina are obtained at all—meets with one decided objection, in that the distinctness and sharpness of the image may always be a matter of doubt. In the illumination test the observer is independent of his refraction and accommodation, as well as of his opinion concerning the sharpness of the image; his task is to decide a simple occurrence: to perceive a distinctly visible motion and tell its direction.

The chief point in the entire discussion must be to test the accuracy of the new method in a practical point of view. Now, in what way do we generally succeed in determining just what refraction is present? Perhaps by testing the sight? If we could rely upon that, there would be no need of any objective determination at all. The testing of vision is based on our endeavor to determine what optical conditions must be fulfilled in order that parallel rays of light may throw sharp images upon the retina without the intervention of the accommodation. But we can only conclude that the retinal images are sharp, when the sight is absolutely perfect. And yet again we ask, but what is absolutely perfect sight? Whoever can see the E of Snellen 60 at 60 *m* has perfect sight, but why should he not have the same acuteness of sight, if he can distinguish any one of the seven letters in series No. 6 at 6 *m?* This is the favorite method of determining sight after cataract extractions. If we look into the affair more accurately and examine all patients in whom we ought to expect perfect sight, to see if they really recognize all of the letters in a given row at the proper distance, we find that but few can stand

the test which is theoretically correct. This is partly due to the imperfection of the test-letters, but more to the fact that we do not, on the whole, obtain mathematically sharp retinal images. The circles of dispersion which compose the retinal image may prevent our seeing with equal acuteness letters of equal size, for the recognition of letters does not depend alone upon their size, but additionally upon their form. And when any one to whom nature has given vision of 6–4, comes with vision of but 6–6, he has lost the same amount of sight as another who had originally vision of 6–6, which now amounts to but 6–9. Perfect sight (vision $= 1$) is therefore an idea, the expression of which compels us to be very choice in our terms. We shall consequently have to be satisfied with the average amount of precision, when we say that the retinal images seen with the refracting ophthalmoscope in the determination of the refraction of the eye in the erect image are distinct and sharp. If perfect vision is not attainable, as happens in the higher degrees of anomalies of refraction, so correspondingly the determination of the far point is equally inaccurate.

We must therefore investigate the accuracy of the illumination test in myopes with good sight. After personally doing this, I am fully satisfied of its usefulness. Nevertheless, when we diagnosticate a myopia of 4 D we hope that no one will imagine that the far point must lie precisely 25 *cm* away. If we discover normal vision with a lens of 4 D, we can, at the most, conclude that the far point lies between 26.6 and 23.5 *cm*. The examination in the erect image gives precisely the same results, except that the limitations of error are doubled. The advantage of the illumination test lies in the fact that it is entirely independent of dioptries and metrical lenses; it enables us to state precisely where the far point lies.

The method of using this test is very simple. A plane mirror is the best to use. The light that serves for the illumination then lies behind the mirror, and at the same distance at which the lamp lies in front of it. Hence the field of illumination is smaller than when we use a concave mirror, which brings an inverted image of the flame directly

in front of the examined eye. The field of illumination must be bright and small in order to enable us to see the motion of the shadow dependent upon the motion of the mirror.

If the surface of the mirror stands perpendicular to the visual line of the observer, the pupil is illuminated red as usual; on rotating the mirror the illuminated field in the fundus moves to one side or the other, and occupies a smaller and smaller portion of the pupillary field, till finally the entire pupil is black. If we have a patient with moderate myopia, the inverted image of the illuminated field lies in the far point, according to the law of conjugate foci. If now we turn the surface of the mirror downward about a horizontal axis, the illuminated field moves in the same direction, and its inverted image will be projected upon the line which unites the source of light and the field of illumination. Therefore, by the same angle by which we rotate the surface of the mirror downward, the inverted image of the field of illumination moves upward, and the darkness of the illuminated fundus follows closely behind it. The condition of affairs is the same, no matter in what direction we rotate the mirror. Of course we can see this motion, but HOW we see it depends upon whether the inverted image of the illuminated field lies in front of or behind our eye. If it lies in front, then we see the motion just as that of any other object,—a movement upward corresponds to the rotation of the mirror downward. If, on the contrary, the inverted image of the illuminated fundus lies behind our eye, when the image moves upward, the illuminated field upon our retina also moves upward, but is projected downward, and a movement of the illuminated field downward now corresponds to a motion of the mirror in the same direction. The same thing occurs when the virtual image of the illuminated field lies behind the examined person, as in emmetropia and hypermetropia.

Hence, when the far point has always been between 20 and 40 *cm*, or has been brought within those limits by correcting lenses, it will be our task to determine the limits between which the movements of the inverted image are

still recognizable in the one and the other direction. And here we have a decided advantage over the examination in the erect image, because we can verify our measurements. If we calculate the refraction from the optical value of the correcting lenses employed, and the situation of the far point thus obtained, the calculation must agree if our observations have been correct.

Every thing then turns on our being able to measure accurately the distance of our own eyes from the eye observed. As the observer keeps the ophthalmoscope close to his eye, and as this distance can be easily computed in the calculation, I have attached to the mirror a tape measure, at the zero point of which is a ring that can be put over the hook held perpendicularly beneath the examined eye.[1] The best way is to approach till we see a movement in the same direction, and then to retreat until the inverted motion of the illuminated field is perceived. The distance between these limits amounts to 1 *cm* when the far point lies between 24 and 36 *cm*. If the far point does not lie within that district, it can be moved there by appropriate lenses; those of 2, 4, 6, 8, 10, and 12 D are abundantly sufficient for this purpose. Each one of these is provided with a hook, to which the tape can be attached. In myopia of moderate degree the lenses will not be needed.

The objection raised by Schmidt-Rimpler,[2] that we cannot tell precisely at what locality the refraction is measured by this test, is not to the point at all. When we use the erect image we cannot tell in what direction the eye is held. It is only when we see the papilla that we know where we are. With the illumination test, on the contrary, we see in what direction the eye is turned, and more than that the position of the papilla is indicated by the brighter tint of the illuminated field. If we were to examine the eye with absolute accuracy, it is not at all the refraction of the papilla that we ought to know, but that of the macula, yet that, as we all well know, cannot be accurately obtained

[1] Perhaps according to Dr. Gordon Norrie's method (*Nagel's Jahresbericht*, 1886, 151), but as the original is inaccessible I cannot say how far our methods are similar.

[2] Handbuch, p. 214.

except by artificially dilating the pupil. But even then the erect image does not offer any well-defined contours about the macula to enable us to state with the necessary scientific accuracy that the image which we have seen is well defined or not. On the contrary, the illumination test is less concerned with the question of the sharpness and accurate definition of the image than with that of the accurate observation of the illuminated field, which is, moreover, perfectly visible all over the entire region of the macula lutea.

The illumination test is of special value in the determination of strabismus. We can also tell whether the case is one of myopic or of hypermetropic astigmatism. Mixed astigmatism, too, is easy to detect. By revolving the mirror in the direction of the chief meridians we can determine their refractive conditions; *i. e.*, the degree of the astigmatic defect. If, however, the chief meridians are situated at an extremely oblique angle, it is often difficult to impart to the mirror a rotation that corresponds precisely with those meridians. Besides this, the objective determination of the degree of astigmatism is generally one's own affair. A decided improvement in the sight is obtained in only about one half of the cases of astigmatism, no matter whether the defect is totally or but partially corrected. The same is observed in high degrees of myopia. The amount that we can objectively demonstrate is almost invariably greater than the weakest lens with which the greatest acuteness of vision is obtained.

CASE OF DEATH AFTER CATARACT EXTRACTION; THE AUTOPSY SHOWING ATROPHIED KIDNEYS.

By DAVID WEBSTER, M.D.

John Burns, a native of Ireland, sixty-five years old, operated on December 7, 1881, by Dr. Webster. Cataract extraction, modified Graefe, upwards, right eye. General health poor. Senile cataract six years' duration. Very good perception of light, but visual field barely ordinary. R. V = light. L. V = $\frac{8}{200}$.

Operation: Graefe, modified, upwards. After the nucleus was extracted the speculum was removed and a few minutes allowed to give the aqueous time to be reproduced. There still remained, however, a membranous-looking substance over a portion of the pupil. A few minutes after the operation Mr. Burns inadvertently pulled the dressing from the eye. Probably no harm done.

December 8, 1881.—Considerable swelling of the upper lid. Bandage removed and cold cloths applied; xv gr. calomel, followed by saline in the morning.

December 9th.—The calomel did not act until late in the afternoon, notwithstanding salines were freely administered in the early morning. Swelling has abated somewhat. Cold cloths and atropine freely used.

December 11th.—Patient totally unmanageable; appears insane, and does all manner of absurd things. Pulls the bandage off the eyes and walks about the room in the mid-hour of night. The eye, notwithstanding these violations, seems to be doing beautifully.

December 12th.—Patient rose from bed and left the ward twice during the late hours of night, and was found wandering over the building. Chloral prescribed at bedtime to keep him still. The

eye, notwithstanding this conduct, seems to be doing unusually well.

December 14th.—Patient for the last two nights has been unusually quiet and orderly, which may be attributed, however, to the influence of the chloral; eye doing nicely.

December 16th.—Some symptoms of iritis, and considerable injection of conjunctiva. Atropine ordered every three hours.

December 18th.—Patient has similar spells to those of a week ago. He rises from the bed at night and wanders around the ward. Right eye now distinguishes objects, and counts fingers at two feet. Chloral in gr. x doses administered at night to quiet the patient and produce sleep.

December 24th.—Doing well. Redness of conjunctiva has about disappeared. Atropine continued.

December 28th.—Atropine as usual.

December 31st.—Patient repeated the strange acts of ten days ago. He arose from the bed during the night and crawled underneath it. Talks incoherently.

January 1, 1882.—Seems very weak; acts like one insane. Pulse weak, and signs of failure.

January 2d.—Pulse better; slightly improved.

January 3d.—Patient died at three o'clock last night.

A test of vision, several days before death, showed that the result was satisfactory. Twenty-seven days in hospital.

Autopsy revealed œdema of lungs and brain, in connection with atrophied kidneys; also extensive atheroma of arteries.

The above notes were copied from the case books of the Manhattan Eye and Ear Hospital by the late House Surgeon, Dr. W. C. Gilliam.

A CASE OF LENTICONUS POSTERIOR.

By H. KNAPP.

THERE are only three cases of lenticonus on record. The first was described by Dr. D. WEBSTER in these ARCHIVES[1] in the year 1875, the second by VAN DER LAAN and PLACIDO[2] in 1880, the third by F. MEYER[3] in 1888. Besides these cases there is a description of the anatomical condition of this anomaly by Prof. O. BECKER[4] of Heidelberg, in his admirable book on the lens, in 1883. He examined the eye of a rabbit, sent to him by Drs. SCHÖLER and UTHOFF of Berlin. The lens showed a conical protrusion in the region of the posterior pole, in which apparently healthy lens-fibres were covered with normal lens-capsule. The specimen, being in bad preservation, did not yield good microscopic preparations. On examining two sections, made of the fellow eye by Dr. Uthoff, Becker could convince himself that the anterior portions of the lens were normal, but that on the posterior pole there was a conical protrusion of 1–5 *mm* in height, somewhat constricted at its base. The case which Dr. D. Webster so well describes, and illustrates by two very good drawings, came from the practice of the late Dr. C. R. Agnew. Dr. Webster had the extreme courtesy to send the patient to me, giving me the privilege of thoroughly examining this then really unique case. It

[1] ARCH. OF OPHTHALM. AND OTOL., vol. iv., p. 382.
[2] Una nuova anomalia de conformação de cristallino, *Period. de Oftalm. prat., rivista bim.*, Lissboã, No. 3, 1880.
[3] Ein Fall von Lenticonus posterior, *Hirschberg's Centralbl. f. pr. Aug.*, Bd. xii., p. 41.
[4] "Zur Anatomie der gesunden u. kranken Linse." Wiesbaden : J. F. Bergmann, p. 126.

referred to a man of 24 years of age, whose sight had always been defective in both eyes. He could read J. 1 with each eye from a distance close by up to 3 inches. With $-\frac{1}{2}''$ and a cylinder, $V = \frac{20}{100}$, in each eye. Externally the eyes showed no abnormity, but when examined with the ophthalmoscope the phenomena produced by keratoconus were present. Oblique illumination at once revealed normal curvature of the cornea but a well-marked conical projection in the central part of the anterior capsule. There was a small posterior cataract, and the whole posterior capsule was dotted over with very minute opacities radiating from the posterior pole of the lens. The affection was alike in both eyes, and if it was not congenital, it certainly was acquired in early youth.

The case of Van der Laan and Placido is known to me only by the abstracts contained in these ARCHIVES, vol. x., p. 497. "Cristalloconus polaris anterior. This anomaly is congenital and progressive. Removal by extraction or discission" (Nieden); and in *Nagel's Jahresbericht*, year 1880, p. 369: "In a man of 23 years there was a conical protrusion of the lens into the anterior chamber, the basis of which occupied about $\frac{1}{4}$ of the anterior surface of the lens. The protrusion differed in no way from the substance of the lens and produced an excessively high degree of myopia, whereas the peripheric part showed H = 3 D. The anomaly was said to have existed 8 years and developed gradually." Whether one or both eyes were affected, is not stated.

The third case was from the private practice of Prof. O. BECKER of Heidelberg, and, on his request, published by his assistant, Dr. F. Meyer (see above). It referred to a boy of 10 years whose **right** eye had been noticed to squint outward for 3 or 4 years, whereas its impairment of sight had been, accidentally, discovered only 9 months ago. The left eye was normal in every respect. With the right he counted fingers at 3.5 *m.* He alleged to see better with −12 D, but could not count the fingers farther than with the naked eye. He read with that eye No. 9 at 5 *cm.* Externally nothing abnormal. Ophthalmoscopically the centre of the red pupil-

lary area presented itself as a red disc surrounded by a variable, movable, dark outline, which separated it from the peripheric red zone. In the centre of the disc three irregular dark spots were noticed (posterior polar cataract). By focal illumination a conical elevation was seen to project from the posterior pole of the lens into the vitreous, bearing on and around its apex three white little patches.

The case observed by myself is as follows:

October 25, 1889, a healthy girl of eight years, Beatrice I., of Minneapolis, was brought to my office. A year previously, when commencing school, her eyes pained her. She had glasses prescribed by an oculist, but found no relief. Her mother is very near-sighted; her father had divergent strabismus. The sight of her right eye was found defective only on examination by an oculist.

Status præsens.—The left eye is normal in every respect. In attentive seeing there is binocular fixation, but soon the right eye moves 3 or 4 *mm* toward the temple. No diplopia. The pupil being dilated with homotropine, she counts fingers with the right eye at a distance of 12′, with $-\frac{1}{12}$, $S = \frac{20}{200} -$. In the inverted image the background is healthy everywhere, but metamorphopsia is marked on the optic disc and the yellow spot. With a plain mirror a sharply defined red disc, of an apparent diameter of 4 *mm*, is seen in the centre of the red pupil, surrounded by black shadows. It resembles an oil globule on water. The corneal reflex is in the disc, slightly below the centre when she looks straight forward, on the upper border when she looks down, but when she looks up, the corneal reflex is just under the lower border of the disc, and this lower border presents itself as a sharp, perfectly black crescent, similar, but more intensely black, than the border of a dislocated lens. The upper border, in this position, is faint. In going from one side to the other, we see blood-vessels and circles and crescents of light and shadow in kaleidoscopic movements. With + 24 we obtain a clear image of the fundus ($H = \frac{1}{24}$). On looking with a plain mirror into the eye from some distance, we notice a double set of blood-vessels, one outside the central disc moving in the direction of my head, and another inside, better defined, moving against it. When from a distance of 3′ or 4′ the eye is examined retinoscopically with a plain mirror, distinct shadows appear on the inner borders of the

central disc, and move against the mirror, whereas with a concave mirror they are less defined and move with the mirror. There is no opacity seen either by transmitted light or by focal illumination. With focal illumination the abnormity cannot be detected. The aunt of the patient, at my request, kindly brought the child to the clinic, where the above-described phenomena were readily noticed by the assistants and students.

The diagnosis: **Lenticonus posterior** could be made without a doubt. The symptoms are so marked, plain and conclusive that an explication of them would only be a rehearsal of well-known conditions. How deep the cone was, and what shape it had, could not be determined, nor can I say whether it was congenital or acquired, stationary or progressive. There was certainly no posterior polar cataract present. The base of the disc lay in front of the centre of curvature of the cornea, about 0.75 *mm*, if I correctly judge its parallactic displacement relative to the corneal reflex. The other eye being perfectly good, I advised no treatment.

This communication puts on record the fourth case of lenticonus. The first and the last were observed in New York, the other two in Europe. Their publications are spread over an interval of fifteen years. Are those cases so rare, or have they been overlooked? I am quite sure that I have seen the kaleidoscopic figures in a number of instances without enquiring more deeply into their cause. I am inclined to think that such anomalies should not be so exceptional at the posterior pole of the lens, though the conicity may vary in degree, and may also have a different shape—for instance, that of a spherical staphyloma or a simple cupping. I can furnish an example of the latter.

Ethel C., East Hampton, L. I., aged fourteen, was brought to me, October 29, 1889. Sight always bad. R $\frac{20}{100}$, L $\frac{20}{200}$. With ophthalmoscope vertical vessels R $+\frac{1}{18}$, L $+\frac{1}{12}$; horizontal vessels $\frac{1}{\infty}$, both eyes. R with $+\frac{1}{18}{}^{c}$ 15^{t} S $\frac{20}{40}$; L with $+\frac{1}{12}{}^{c}$ 15^{t} S $\frac{20}{70}$. Fundus normal. On examining, the media—pupil undilated as well as dilated—a sharply defined disc is seen in the centre of the pupil, the circumference being a distinct line as if drawn with a

pencil. The adjacent part of the pupil less red, but with no moving shadows as in the case of lenticonus. The small circle encloses the corneal reflex, is below it when the eye looks down, above when the eye moves up, etc. I put down the diagnosis: Regular and irregular astigmatism, and prescribed the above cylindrical glasses. The cause of the irregular astigmatism may be found in the anomaly of the posterior pole of the lens. There was no opacity, and the cupping could not be seen with oblique illumination. The depression with its sharp edges was very striking and readily seen by other oculists and students.

I would call it: *Ectasia or excavation at the posterior pole of the lens*, and consider it a congenital and stationary anomaly of conformation.

THE NERVE TERMINATIONS IN THE CORNEA.

By Dr. EMIL BRAND, of Leipheim.

Translated by Dr. J. A. Spalding, Portland, Maine.

(*With plates v. and vi. of vol. xix. Germ. ed.*)

COHNHEIM'S introduction of the gold-chloride method into the technique of histology has so facilitated investigations into the nerves of the substantia propria of the cornea, that there ought not in these days to be any difference of opinion in regard to the arrangement of the coarser ramifications in this region.

The state of affairs is, however, quite different when we consider what we know about *the terminations of the corneal nerves*, for every new paper advances views which the author retracts or largely modifies in succeeding articles, so that it is difficult to make any advances in this disputed province, whilst at the same time we see how inefficacious are our methods, though most of them are the gold-chloride, modified in one way or another.

It is generally assumed that the substantia propria of the cornea is filled with layer upon layer of nerve fibres, the uppermost layer of which sends off numerous branches (rami perforantes), climbing more or less steeply toward the anterior corneal epithelium, not so far as the lowest epithelial layers, but beyond the elastica anterior, where they form a network, the subepithelial plexus (Cohnheim). From the latter in turn arise delicate fibres, which, passing perpendicularly through the lowermost layers of epithelial cells, form in the superficial layer of the pavement epithelium the

intra-epithelial plexus (Waldeyer, *Graefe-Saemisch*, Bd. I., p. 207). It is concerning the terminations of this plexus that opinions vary.

Koelliker and Cohnheim assert that these terminal branches end in a free filament or with a little swelling at the end, but Waldeyer says that they dissolve into a network. Waldeyer later withdrew this assertion and agreed with Izquierdo that the nerve fibres terminate in the epithelium free, or provided with a slight tumefaction. Klein (*Quart. J. Mic. Soc.*, 1884, p. 59) next opposed this view, and thought that the nerves terminated in a network of delicate varicose fibrillæ between the epithelial cells, but that this appearance did not extend over a great surface and had for that reason escaped the notice of many competent observers. Wolf has recently revoked all that he said in previous articles, and now denies any connection of the nerve fibres with the epithelial cells, or with the connective-tissue cells in the corneal stroma. Finally, we may remark that Goldscheider, in a recent paper on the nerves of the skin (*Arch. f. Anat. u. Phys.*, 1886, Reprint, p. 186), states that all apparent terminations of nerves in the epithelium are merely a self-deception.

The question of the termination of the nerves in the stroma of the cornea was opened by Kuehne, who said that they were connected with the protoplasm of the corneal cells. This was at once denied by most observers, but has since been granted by Waldeyer and Izquierdo, whilst Klein believes in a free termination.

This summary of the question of the nerve terminations in the cornea may suffice to show that a disagreement in regard to the final offshoots still exists, and that whether the terminal branches of the intra-epithelial plexus represent nerve fibres terminating freely or in a reticulated meshwork is not yet settled.

I have lately discovered, greatly to my astonishment, *that there is no subepithelial or inter-epithelial plexus, but that the so-called rami perforantes are really the final terminations of the corneal nerves and support the terminal nervous organs.*

I will first attempt to show the errors that have given

rise to the mistaken view of the existence of an epithelial plexus.

Chloride of gold possesses the peculiarity of staining, precisely like the nerve itself, not only the component parts of the nerve, but many other tissues, to say nothing of fissures and cracks in the cornea. Amongst others, it stains the cement substance of the epithelial cells, just as nitrate of silver stains the cement substance of the endothelial cells.

Thus Koelliker ("Gewebelehre," figs. 175 and 463) depicts a bit of rabbit's cornea treated with gold chloride, and says of it: "We see indistinct contours of the deepest perpendicular epithelial cells, and above them the ends of the free axis-cylinders lying between the superficial pavement-epithelium cells not represented in the figure."

Now a glance at Fig. 1, *a*, shows that I had before me precisely the same pictures, which, however, only present the gold-tinted cement-substance of the uppermost pavement epithelium, which I then show side by side from the same preparation (Fig. 1, *b*), only from a region where they are completely stained.

The most superficial pavement epithelia in *young* rabbits are unusually large in comparison with the subjacent epithelial cells, whilst the nuclei of the pavement epithelia are very small, and the latter are not always stained with the gold chloride. It is therefore easy for us to be deceived, especially when we meet with imperfectly impregnated specimens, more or less shrivelled or teased out according to the method by which they have been treated. In older rabbits the superficial epithelial cells are smaller, and I surmise that Klein has mistaken the outlines of these gold-stained cells for a network of nerve fibres.

The very fact that the gold chloride is unfitted to exhibit the nerve fibres in the epithelial layer makes me believe that it never can give us positive preparations, because it tints the connective substance of the epithelial cells as distinctly as the component parts of the nerves. The same may be said of meridional and perpendicular sections, which have the disadvantage, that if the section turns out too thick, or if it falls too obliquely, perspective

deceptions easily transport into the epithelial strata structures that really lie in the horny stratum.

It has also long been known, that the gold chloride tints the offshoots of the corneal cells so that they may be mistaken for portions of the nerves.

It may be less well known, however, that gold chloride stains but a portion of the nerve, probably on one side only, the one upon which the light first touches it. Hence the nerves, and especially the finer fibres, appear too minute. And most to be emphasized, *the terminal nervous organs*, described anon, are tinted on one side only, and so imperfectly that they are with difficulty recognized, and have for that reason, in all probability, up to this time escaped observation.

I employ gold chloride either in the usual way of hardening rabbits', cats', and human corneæ in a 5 % solution, and then making sections, or in subsequently placing similarly hardened corneæ in very dilute acetic or pyroligneous acid.

If we now shave off successive horizontal sections of the epithelium, we often get sections in which the deepest epithelial cells have been divided below the nucleus, so that the cell contours tinted with the chloride form a gorgeous mosaic and permit us to see all the subjacent tissue (granules and nerves of the cornea, and perforating branches), especially when we examine them in glycerine. I have never been able, even in the most successful preparations, to discover the subepithelial plexus so often described, but the terminal branches of the rami perforantes always demanded a deeper adjustment than the basal seams of the deepest epithelial cells—in other words, they do not extend beyond the corneal stroma. In successful preparations from rabbits I saw even with this method of treatment the rami perforantes terminating in a small tumefaction and a little head [whilst the edge of the cornea on cross-section showed a slight incurvation (Fig. 2)].

The same result can be more easily attained by the second method. The action of the acetic acid for several days easily loosens the epithelium from the corneal stroma, but in such a way that the contours of the basal seams, tinted with

the gold chloride, remain at the surface, so that the above-mentioned conditions can be easily seen on horizontal sections. Nevertheless, it is well to make a previous examination of the section with the epithelium intact for purposes of verification.

Preparations treated with acetic or pyroligneous acid can be subsequently stained by dipping them for a few minutes in a slightly acidulated solution of acid fuchsin, which gives as excellent pictures as the gold chloride, and can also be combined with the latter. Unfortunately this acid shares with other aniline tints the disagreeable property of fading, and washing out the picture when glycerine is added. For this reason all these preparations must be examined in acidulated water.

I have obtained still better results by the method used so extensively in the examination of nerve tissues—*i. e.*, hardening in chromic acid. But whilst most experimenters use Mueller's solution, or weak solutions of chromic acid, I use the latter in a 5 % solution. The entire globe is placed in this, and is hard enough to be cut in four weeks. Rabbits' eyes are hardly suited for this method; it is better to use human eyes or those of the cat. Good results are occasionally obtained in rabbits.

Horizontal sections are the best for examining the nerves; the edges of the corneal lamellæ that intersect with one another in these sections in a star shape (*) occasionally obscure the picture. The same accident may occur from a few offshoots of the corneal corpuscles, and a sort of wandering cell which greatly resembles the muscular cell, although it has the biscuit-shaped nucleus of the migratory cells. This type of cell I saw in all the animals that I examined, but no mention of them is made in the text-books.

If we wish to know about the surface of the network of nerves, we must place the chromic-acid sections into weak (1 %) solutions of silver nitrate, whereby crystals of chromate of silver form along the nerve sheaths, and thus distinctly indicate the course and distribution of the nerve. We also get at the same time beautiful pictures of v. Reck-

linghausen's juice-cell system. For finer investigations these preparations are useless.

Chromic-acid corneal sections when examined in glycerine (the nerves can hardly be recognized in Canada balsam) exhibit the nerves as reddish glittering structures upon a greenish background. No further coloring is necessary, but if really desired acid fuchsin is the best.

The result of this treatment is that the nerves look as if composed of several fibres, surrounded with a common sheath, which, provided with rather long nuclei, pointed at both ends, penetrate into the cornea. The trunks split into branches with a few twigs which lie close to one another as flat structureless bands (axis-cylinders), and are constantly surrounded with a common membranous sheath thickly strewn with the elongated nuclei. (The nuclei on the sheaths are probably nuclei of endothelial-like pavement cells.) The nerve ramifications, composed of several fibres, now split and separate at almost right angles to one another until every twig consists of a single axis-cylinder surrounded with a nucleated sheath. The location of every nucleus is shown by a spindle-shaped elevation (the varicose swelling in gold preparations). The spot at which the nerves ramify is indicated by a roundish granular nucleus, regarded by some as a ganglionic cell, by others as an adjacent corneal corpuscle, but which is really nothing but a modified nerve-sheath nucleus. These are very distinct and delicately granulated (Fig. 3) in rabbits, hares, deer, and sheep, but there is no trace of them in cats, whilst in man they are not always easy to discern.

The nerve fibres in the chromic-acid preparations are much more distinctly defined and broader than those treated with gold chloride. To be sure the nerve substance is here and there shrivelled by the strong reagent, and coagulated in drops at several spots within the sheath, whilst the sheath at many localities seems empty. But on the whole the natural appearance is very well preserved.

When the nerve stems have divided into a few axis-cylinders, the latter push forward to some dividing point and there unite with another nerve fibre ; nevertheless, *one*

branch arises more or less steeply from many points of division toward the anterior corneal epithelium, the so-called rami perforantes.

These nervous twigs, when separating at the point of division, look very much like the usual anastomosing branches, and often exhibit a nucleated sheath. *But as the perforating branch reaches forward, it swells and bears upon its termination the nervous organ in the shape of a peculiar thickening.*

This organ varies in different species and in various individuals, and even in the same eye, but *none that I saw ever arose above the corneal stroma.*

After removing the uppermost layers of the epithelium in rabbits by successively horizontal sections, I found club-like terminations with a little button at the summit (Fig. 4), the latter still lying beneath the base of the deep epithelial cells. I did not succeed with the nerve terminations in perpendicular sections of rabbits' corneæ. On the contrary, I made some very useful perpendicular sections in adult cats (Fig. 5, *a*, *b*, *c*), where the thickened nerve structure rises perpendicularly to the epithelial layer, but terminates beneath the base of the perpendicular lowermost epithelial cells. I also succeeded, by removing, in horizontal sections, the epithelia as far as the lower half of the cylindrical cells, in seeing the nerve terminations from above; they form a club-shaped tumefaction with a lateral offshoot. Here too the actual end is button-shaped, and plainly underneath the level of the deepest epithelial cells, as we distinctly proved in the horziontal sections (Fig. 6, *a*, *b*, *c*).

It is easiest to demonstrate the nerve terminations in man. For we have beneath the deepest epithelial cells a second stratum, Bowman's or Reichert's membrane, which is either entirely absent in the animals previously examined, or represented solely by a very slight thickening of the lowermost portion of the deepest epithelial cells.

If we make perpendicular sections through the human cornea, no matter whether hardened with gold chloride or chromic acid, we shall find the elastica anterior entirely free from nerve fibres. If, however, we make the sections

a little obliquely, we find in almost every one a nerve termination that apparently extends into the epithelium. This deceptive appearance can be easily explained when we make horizontal sections with the razor, partially scrape away the epithelium, and then loosen the lamellæ by a further horizontal section parallel to the first. If now we strip off the still remaining epithelial stratum with the needle, we shall often obtain a nice preparation of the elastica anterior, in a few spots only shall we find traces of the lowermost portions of the deepest epithelial cells, forming at the same time a proof that the elastica anterior was preserved intact.

Whilst now in such preparations we have the microscope adjusted above, or just into the elastica anterior, we see nothing of the nerve elements, yet the moment that we adjust it deeper and into the corneal stroma, we see in a most surprising way these same elements in their connection with the rest of the nerve-fibre plexus. I succeeded in this way in demonstrating no less than eight nerve terminations in a lamella of the human cornea 2 *mm* wide and 1 *mm* long, whereby we proved the regular arrangement of these corpuscles, and were able to draw some conclusions in regard to the probable number in any given cornea (Fig. 8).

When we have once caught these terminal corpuscles in horizontal sections in the manner indicated, we can often though not so frequently discover them in perpendicular sections, when they lie in distorted clusters beneath the elastica anterior.

The form of the terminal corpuscles varies greatly in the same individual. The simplest ones are club-shaped; the others are dichotomously ramified, but even then their terminations are club-shaped (Fig. 7, *c*).

Many of the corpuscles exhibit a club-shaped thickening with generally five horn-like prolongations, three of which rest upon the extreme end of the swelling, and one or two a little to the side (Fig. 7, *d*). (For the latter condition observe the peculiar offshoot at the foot of the terminal corpuscle in the cat.)

All of the corpuscles exhibit a sheath-like envelope, the

prolongation of the nerve sheath; the incurvations noticeable in many pictures of the corpuscles evidently depend upon the action of the chromic acid on the nerve substance.

There is hardly any need of calling especial attention to the resemblance between these corpuscles and the Pacinian corpuscles, tactile corpuscles, and *Krause's terminal club-shaped bodies in the conjunctiva.* (W. Krause also mentions button-shaped nerve terminations in the cornea, but his original paper is just now inaccessible.)

After once finding the terminal nerve corpuscles in chromic-acid preparations, it is much easier to discover them in the gold-chloride preparations, although we do not invariably succeed. For the sake of comparison, I show a sketch of a gold-chloride preparation (Fig. 7, *a* and *b*), and beneath it a nerve termination from the other eye of the same person, though hardened in chromic acid. The nerve fibre in gold preparations generally appears to terminate in a thread-like filament (possibly because the terminal corpuscle is tinted on one side only), so that we are often deceived by the presence of similar thread-like structures close at hand, which are, however, nothing but the prolongations of the corneal corpuscles.

The remaining terminations of the nerve fibres in the stroma of the cornea itself always unite with other fibres. We often see corneal corpuscles lying close to the nerve fibres, but I have never been able to prove that there is any connection between them.

I hope that what I have here offered for publication may induce others to investigate the subject more closely and to verify my latest views. I would also emphasize the need of looking at this important question with much care, in the expectation that those who have at their command more human eyes than I have been able to get, may accurately cultivate the investigation of the terminal nerve organs, because the eye of man offers, as I am well convinced, many more chances for discovering these important and interesting corneal structures than almost all other species of creation combined.

Explanation of the Drawings on plates v, and vi.

Figs. 1 to 7, 420 diameters, Leitz eyepiece 1, objective 7.

Fig. 8, 240 diameters, Leitz eyepiece 1, objective 5.

Fig. 1. Cornea of rabbit treated with gold chloride, horizontal section. Corneal epithelium seen from the external surface. We see the borders of the superficial epithelial cells at *a* imperfectly stained, at *b* perfectly stained, with nuclei.

Fig. 2. Perpendicular section through the cornea of a rabbit treated with gold chloride without the epithelium. Ramus perforans with nerve terminations (*a*).

Fig. 3. Rabbit's cornea treated with chromic acid; horizontal section. Subdivision of a nerve fibre. Sheath-nucleus of a nerve-fibre sheath (*a*); the nerve sheath (*b*), at a point of subdivision.

Fig. 4. The same preparation. *a* a nerve terminal corpuscle of a rabbit seen from above.

Fig. 5. *a*, *b*, *c*, perpendicular section through the cornea of an adult cat, treated with chromic acid. α a terminal nerve corpuscle.

Fig. 6. *a*, *b*, *c*, horizontal section through the cornea of an adult cat, hardened with chromic acid.

Fig. *a*. α the bases of the deepest epithelial cells divided below the nucleus. β the terminal nerve corpuscles. γ peculiar lateral offshoot. δ nerve fibre. δ' ramus perforans. ε swelling of the nerve sheath. ζ point of division.

Fig. *b* and *c*. Other forms of the terminal nerve corpuscles. The same references.

Fig. 7. *a*, *b*, *c*, various forms of the terminal nerve corpuscles in man.

Fig. *a*. Left eye hardened in gold chloride; horizontal section.

Fig. *b*. Right eye hardened in chromic acid; horizontal section. α deepest layer of the epithelial cells divided below the nucleus.

Fig. *c*. Human eye hardened with chromic acid; horizontal section. Ramus perforans and terminal corpuscle. α the nerve-sheath nucleus.

Fig. *d*. Human eye hardened in chromic acid; horizontal section. Terminal nerve corpuscles. The nerve sheath is ruptured at several places by the action of the chromic acid.

Fig. 8. A piece of a human cornea, 2 *mm* long and 1 *mm* broad, hardened in chromic acid; horizontal section precisely from

the middle of the cornea. Epithelium of anterior surface pulled away, but quite a bit left at *a*; the rest removed with the preparing needle. At *b* we see the remains of the deepest cellular layer left behind. The delicately granular surface indicates the totally structureless elastica anterior. The fixed corneal cells are not represented, but we see numerous migratory cells (ϵ). They often lie just beneath the elastica anterior, and at one spot right above an offshoot of a terminal nerve corpuscle (d'), whilst the extreme summits of the latter ($e\ e$) attain a higher level.

α nerve fibres. β terminal nerve corpuscles. (β' simple club-shaped.) γ rami perforantes. δ branches of the nerve fibres leading to trunks lying farther below.

GLYCOGEN IN THE CORNEA AND CONJUNCTIVA OF PATHOLOGICAL EYES.

By Dr. A. SCHIELE,

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(*With plates vii. and viii. of vol. xix. German edition.*)

Translated by Dr. H. A. Bournonville-Macauley, of New York.

IT occurred to me while reading Dr. O. Beselin's article entitled "Amyloid Substance in the Cornea of a Staphylomatous Eye,"[1] that the substance in question was probably glycogen instead of amyloid, and I soon found an opportunity to confirm this supposition. This task was rendered much easier by the fact that I had already treated of glycogen in my inaugural dissertation entitled "Glycogen in Normal and Pathological Epithelium."[2]

In that paper I demonstrated that glycogen, a homogeneous, hyaline, highly refractive substance, of very viscid consistency, is found in all normal mucous membranes covered by numerous layers of pavement epithelium (mouth, tongue, pharynx, œsophagus, vagina, etc.). Furthermore, that in the less pronounced epithelial layers of the cornea and conjunctiva, and the still thinner epithelial covering of the genito-urinary apparatus, no trace of glycogen is found; and finally, that the so-called transition epithelium or cylinder epithelium, whether it be simple or ciliated, does not contain glycogen. I also examined cancerous growths and found that "wherever there is a luxuriant cancerous proliferation with extensive epithelial cones composed of large,

[1] These Arch., vol. xvi., No. 3, p. 313.
[2] Berne, April 28, 1880. In Prof. Langhans' Pathological Institute.

differently shaped cells, in a word in '*infiltrated epithelial cancer*,' there we find glycogen." "Finally, I examined several papillomata and condylomata and have met more or less glycogen, varying with the character of the cell proliferation and the size of the cells. The general condition and age of the individual not being considered, owing to the greater amount of glycogen in the newly born infants as compared with adults, and the disappearance of glycogen as well as fat in emaciation, the percentage of glycogen is in direct proportion to the number of layers of the investing epithelium, the size of its cells, and the extent of cell proliferation. For instance, the normal cutis, stratum corneum and stratum Malpighii, contain no glycogen, while it was found in considerable quantity in the large polygonal multinucleated cells of the hyperplastic mucous membrane of a condyloma of the upper part of the thigh. This explains the presence of glycogen in the epithelium of the cornea in *staphyloma corneæ totale*, described later on, where proliferation of the epithelium had been the result of inflammatory irritation. The explanation of the appearance of glycogen in *spring catarrh of the conjunctiva* is also furnished by the pronounced cell proliferation in the region of the limbus, and finally a case of *cancer of the conjunctiva* is appended, marked by a peculiar change in the cornea, in the proliferated cells of which, as well as in the affected parts of the limbus conjunctivæ, the cornea, epidermis, hairs (outer sheath), and skin of the lid, glycogen was found plentifully. Before beginning with the special description of the above-named cases, I again examined the cornea, conjunctiva bulbi et palpebrarum, and the skin of the lids, for glycogen, and as before obtained a negative result. In the normal as well as the pathological cases, I used a strong solution of iodide of potassium for this purpose, according to the methods of Ranvier ("Traité Technique d'Histologie"), Neumann ("Die Jodreaction der Knorpel and Chordazellen"), and Godet ("Recherches sur la Structure Intime du Placenta du Lapin"[1]) and where glycogen was present, obtained a mahogany-brown (Ranvier) or wine color. I am indebted to Prof. Pflüger

[1] Inaugural Dissertation—Berne, 1877.

for his kindness in furnishing me with the following three cases.

Sclero-Corneal Staphyloma.

(*Plate vii., fig. 1.*)

Marie H., 7 years old. History of measles when two years old, during the course of which an ulcer appeared upon the cornea (keratitis pustulosa) of the left eye. This was probably followed by perforation of the cornea, and a subsequent leucoma adhærens totale corneæ was the final result of the inflammation. From this time on there was progressive enlargement of the whole globe. The eyeball is enormously enlarged and the eyelids can only be closed with great difficulty. The diameter of the cornea is extraordinarily great, but it is not arched forward very much. In the lower middle segment of the opaque cornea is noted a large yellow uneven *placque*, about 5 *mm* in size. The whole region of the ciliary body surrounding the cornea is puffed out and of bluish-gray coloration. Eye painless. T not tested. S = o.

April 17, 1886. The cornea was removed with the broad cataract knife and scissors, and the loosened conjunctiva bulbi drawn together like a pouch, so as to hide the gaping wound. Contrary to the usual method, the preparation was hardened in absolute alcohol only.

Macroscopic Appearance.—The grayish-yellow cornea shows a horizontal diameter of 18 *mm*, a vertical diameter of 15 *mm*. At the above-mentioned yellow prominent spot it is about 1.5 *mm* thick; excepting this irregularity, the cornea is exceedingly thin, and becomes gradually thinner, until it joins the likewise atrophied sclerotic, the angle of insertion being very slight. Upon the posterior surface of the cornea a scanty blackish deposit is observed; the tissue of the iris is in direct apposition with the cornea throughout its whole extent, and so intimate is this relation that there is no sharply defined dividing line, and the pigment of the iris has insinuated itself into the corneal tissue in many places.

Microscopic Appearance.—A small triangular piece was cut out of the yellow prominent part of the cornea, and numerous sections were made through its entire thickness. These

were suspended in a solution of the double iodide of potassium, and afterwards examined with low power. The following appearance was obtained (Fig. 1): Corneal epithelium, which is intact, sends down well-developed epithelial cones (*a*) to the deeper parts, into a newly formed cellular layer (*b*), the membrane of Bowman being lacking; below this is seen the substantia propria corneæ (*c*), and finally the adherent iris (*d*).

As regards the action of the solution of the iodide, the uppermost layer is colored a dark- or blackish-red, the intensity of which decreases downwards. The middle cellular layers show small dark-red crescents.

The newly formed layer of connective tissue adjacent to the epithelium is very rich in cells, and shows the same wine-red coloration in streaks and droplike aggregations of color. The substantia propria corneæ has a similar but much more regular appearance; upon a yellow ground are disposed small red streaks, sometimes drawn out into longer lines, which are constantly parallel to the superficies of the corneæ, and correspond to the course of the corneal lamellæ.

At various points, in addition to these red streaks, the tissue is tinged a diffuse wine-color. The injection has probably penetrated to these points by imbibition. In the substantia propria corneæ are numerous sections of vessels (*e*), and next to these is seen the adherent iris, or, rather, its pigmentary epithelial layer.

Under high power (Zeiss: Oc. 2, Obj. E.) these streaks in the substantia propria prove to be the "*fixed corneal cells*" *containing glycogen*, lying in the lacunæ of the canalicular system. The glycogen presents itself in many instances in the shape of fine granules, at times, however, occupies the entire "cell"; in other cases the cell is filled with a single drop or with several small ones. Almost all the "corneal cells" show more or less glycogen. The lamellæ present nothing abnormal. The regular structure of the lamellæ gradually blends above with the *newly formed* (already described by *Beselin*) stratum of young *wavy connective tissue*, very rich in cells, running parallel to the superficies and

lying directly under the epithelium. This layer is traversed by numerous vessels. Glycogen masses are also found here, apparently derived from the epithelial and lymphoid cells (perhaps also from the corneal corpuscles). No trace whatever is to be found of *Bowman's membrane*, and we pass on to the *epithelial layer* (*a*). This is formed of numerous layers, processes from which sink down into the newly formed substratum of connective tissue.

Very pretty characteristic cells are seen in the middle layers, in which the glycogen is arranged in wine-colored crescents situated at the lower half of the cell. The upper cellular layers are flattened down, and for this reason the glycogen here appears blackish-red. The basal cells contain no glycogen. The epithelial layer is hollowed out in places, doubtless due to the falling out or disintegration of the cells during the perforation of the cornea. The masses of glycogen, becoming free, have forced themselves through the burst spaces of Bowman's membrane, and have located in the upper layers of the corneal lamellæ under that membrane. The spaces mentioned, as well as the entire disappearance of the membrane of Bowman, have a certain connection with the formation of the newly formed subepithelial layer, as, in all probability, an invasion of round cells from the limbus has taken place (*vide* "spring catarrh" and "carcinoma conj.") and these cells, crowding in between the epithelium and Bowman's membrane, have formed the layer above mentioned, but at the same time have destroyed Bowman's membrane, and thereby opened the way for the glycogen masses into the uppermost layers of the lamellæ of the cornea.

Spring Catarrh of the Conjunctiva.

(*Plates vii., viii., figs.* 2, 3, 4.)

Mr. N., thirty-five years old, private patient of Prof. Pflüger, has had for a long time an affection of the eyes, with regularly recurring exacerbations every year about April or May; the symptoms are mitigated in the autumn, but do not entirely disappear. Each remission commences with burning and weeping of both eyes. This year, owing to the unusually rapid advance of

the "film" towards the middle of the cornea of the right eye, the patient determined to submit to more energetic treatment.

Status.—The limbus conjunctivæ in both eyes, upon the temporal side, is much broader, granular with "gelatinous infiltration"; its upper, lower, and nasal parts are free and not thickened. That part of the conjunctiva bulbi which, corresponding to the space between the lids, borders upon the swollen region of the limbus, is somewhat elevated, yellowish red, and of triangular shape, the base of the triangle merging into the limbus. The rest of the conjunctiva bulbi is normal.

Conjunctiva palpeb. is moderately injected, that of the under lid being slightly milky white, but showing neither papillary nor fungoid proliferations.

Although the proliferation of the limbus of the left eye over the corneal border is very slight, the right eye, however, shows an entirely different picture.

Right Eye —The jelly-like and elevated temporal limbus is bounded upon one side by the triangular (about six *mm* long) hillock of the conjunctiva bulbi, while on the other side it becomes broader and is continued over the surface of the cornea as a small tumor pushing itself towards the centre. This flat neoplasm is about one and a half *mm* thick and about five *mm* square; its surface is almost smooth, with slight eversion of its anterior border, and it has a pale "jelly-like appearance," resembling its point of origin, the hypertrophied limbus. April 25th, this mass was separated from the cornea at its base, with which it was intimately adherent, by means of the broad cataract knife and removed. The abrased surface was then treated with the galvano-cautery. *During the operation a small piece of the superficial corneal substance was accidentally removed with the tumor*, as may be noticed by reference to Fig. 2 (*c*). The proliferated parts of the limbus were also removed. The parts thus obtained were left in alcohol for several days, and then examined.

Upon examination of Fig. 2 the *enormous thickening of the epithelial layer* is at once obvious, especially at the prominent anterior border of the neoplasm; the manifold shapes of the numerous cone-like extensions of the epithelial layer reaching down into the sub-epithelial stroma of connective tissue are also very remarkable. These cross each other in some places, and where the section has passed

through transversely, the appearance of concentrically arranged epithelial nests is produced (*g*). This field was obtained by low power (Zeiss, Obj. A, Oc. 2) and reminds one vividly of epithelial carcinoma. Vetsch [1] and Uhthoff [2] have already called attention to this point. Between the sharply defined epithelial cones the stroma of connective tissue intrudes itself, *copiously infiltrated with round cells.* Sometimes these cells are collected together in large heaps, mostly at points directly under the proliferated epithelial layer, divided from it only by a narrow seam. These cellular aggregations were mostly found in the region towards the limbus (*b*). In the neighborhood of the anterior border of the growth the epithelial proliferation gains the upper hand (*d*). Cell infiltration is less marked in the middle layers of the stroma, but becomes more pronounced in the neighborhood of the underlying corneal lamellæ (*b*). As shown by the illustration, Bowman's membrane and the small portion of corneal tissue (*c*) accidentally removed have been *broken down* in two places *by cell-masses*, and these have collected just under the layer of Bowman. From these infiltrated parts similar proliferated tracts pass down into the deepest layers of the neoplasm, for the most part running in the direction of the anterior free border. The tissue as a whole is very poor in blood-vessels, and in isolated instances only are large vessels seen, surrounded by an infiltration of round cells.

If unstained sections are scanned under low power, the first thing which catches the eye is the almost homogeneous, peculiarly light shining appearance of the uppermost epithelial layer, which is separated from the deeper layers by a sharply defined boundary line; the latter, however, as well as the cellular layers of the cones and "pearls" (*g*), show the same waxy shine, although it is not so pronounced. If the same sections are suspended for several minutes in a dilute solution of the double iodide, the picture is changed as follows: The superficial sharply defined zone has become

[1] "Frühjahrscatarrh der Conjunctiva," Inaug. Dissert., Ulrich Vetsch, Zürich, 1879, S. 35.
[2] Frühjahrscatarrh, W. Uhthoff, *v. Graefe's Arch.*, Bd. xxix., 3, S. 177.

mahogany red and the remaining epithelial layers, as well as an occasional aggregation of round cells, are stained more of a wine-red; the remaining tissue is tinged with yellow. If these colored specimens be examined by high power (Zeiss, Obj. F, Oc. 2), it is found that the brown-red upper epithelial layer (by low power) is composed of isolated red strands which correspond to the flattened cells, and further, that the wine-red mass in the reef cells is made up of fine granules and situated sometimes only at the side or at the lower part of the cell-body. Finally, in the granulation cells, or numerous round cells infiltrating the stroma of the neoplasm, and also in the fusiform connective-tissue cells, the coloring substance was sometimes diffused homogeneously throughout the whole cell; in other cases separated into drops, occupying only one corner of the cell. The nucleus of these cells gave no reponse to the tests for glycogen.

Returning now to Plate vii., Fig. 2, it is seen that the granulation cells have broken through Bowman's membrane in two places (*f*), and then assembled in the upper layers of the substantia propria corneæ, directly under the above-mentioned membrane.

Now it seems to me that this pretty active participation of the cornea in the process of the proliferation of a neoplasm explains the persistent corneal opacities which remain behind in such cases, for as the neoplasm encroaches upon the cornea from the region of the limbus, the advancing granulation cells shove themselves between the corneal epithelium and Bowman's membrane, break through the latter (*d*), and sink down into the underlying lamellæ of the cornea. As a sequel of this, corneal opacities of different size as well as depth may form, varying in extent with the intensity of the proliferative process.

In cases of very pronounced proliferation after the catarrh has subsided and retrogressive metamorphosis has begun in the granulation tissue (pannus), the corneal epithelium re turns to a condition approaching the normal, but *permanent opacities* of the cornea of various shapes and extent may still persist. These are mostly bow- or ring-shaped. Vetsch

and Reymond have already reported that *papillary growths upon the conjunc. palpeb.* are a not infrequent symptom of spring catarrh; the following case is an excellent example of this.

Fred. Wälti, thirteen years, has suffered for three years with an affection of both eyes, the subjective symptoms of which are slight darting pains, burning and weeping of the eyes. In the left eye only fungous growths are seen upon the conjunctiva of the upper lid. Patient does not remember definitely when the growth first appeared. Changes of the limbus and conjunctiva of the globe are not apparent. According to the boy's statement, the growth increases in the spring and gets smaller in winter, but never entirely disappears.

Status.—Conj. palp. sup. o. d. and conj. palp. inf. oc. amb. appear normal, and do not show the whitish color usually noticed in these cases. Cornea quite clear.

Left Eye.—Slight ptosis. Conjunctiva of upper lid when everted presents a granular appearance, due to prominences which cover its surface and are connected with it by thin pedicles (Fig. 3). The entire tarsal part of the conjunctiva, as far as the free border of the lid, is occupied by these growths, crowded thickly together, and varying in size. The fornix and inner corner of the connective tissue of the lid are free from these excrescences, but nevertheless are swollen and whitish. About a year ago (May, 1885) these fungous prominences were removed with the scissors and the wound scarified with the galvano-cautery, but returned again in about a month in the same place, as large as before. In May, 1886, several of the larger excrescences (*a*) were again removed. These were about 2–4 *mm* in diameter, pale red, and felt quite tough. They were immersed in absolute alcohol and allowed to harden.

Upon examination of longitudinal sections of these growths (Fig. 4) with the microscope (Seibert, Obj. I, Ocul. III.), the epithelium above was seen to be moderately thick and somewhat flattened, while at the sides the cells were more round. *The stroma for the most part consisted of lymphoid cells* (*b*), traversed by scanty bands of connective-tissue fibres. The tissue is fairly vascular (*c*). In the midst of the granulation tissue are seen tubular epithelial depressions in cross- as well as long-sections; these are the so-called

trachoma glands (*d*). In the lumen of these glands, in addition to the usual detritus (*e*), there are also seen quite a number of goblet cells, sometimes appearing to have no connection whatever with the epithelial walls. The fundus of the depression shows numerous round cells in the deeper layers, while the more superficial strata are made up of cylindrical cells of a peculiar narrow drawn-out form. The presence of these epithelial depressions, or trachoma glands, is another evidence that they are by no means specific in trachoma. The numerous goblet cells in the glands of our excrescences would seem to indicate a catarrhal condition. *I did not come across follicular formations.* As regards the genesis of these fungous growths, they should be regarded as proliferations of the adenoid substance of the conjunctiva, or so-called "pseudopapillæ."[1] As happens in blennorrhœa of long duration, there is also here considerable proliferation of the reefs (Stieda), and papillæ-like prominences of the mucous membrane of the conj. palp., which, pressing against each other, are mutually flattened, and give the surface of the mucous membrane an appearance as though it were plastered over. This flattening is not only due to the reciprocal pressure of the two structures, but also comes from the outside, owing to the fact that normally the conjunctiva of the lid is in intimate contact with that of the globe, so that movement of the latter causes a sliding motion of one surface upon the other, and in this way the slightest unevenness of the surface, inasmuch as it is composed of soft mucous membrane, is flattened down, or ground off, as it were. In this case also, I look upon the extensive proliferation of the adenoid tissue of the conj. palpeb. as the prime factor, and assign a secondary rôle to the slightly and not proportionately increased epithelial layer, regarding it as dependent upon the increase of the volume of the stroma. This spring I saw the final result in both of the cases cited above, an entirely smooth, glistening, atrophic conjunctiva palp. sup., but, contrary to the rule in trachoma, quite movable upon the underlying structures; slight ptosis was noted in both cases.

[1] *Arch. f. Ophthalm.*, Bd. xxix., Abth. 2. Rælhmann, S. 112.

I also had an opportunity for the microscopical examination of a *conjunctiva bulbi*, affected with "*spring catarrh*," in which the limbus conjunctivæ was intact.

Hans Gerber, eight years, right eye affected, left eye healthy. The following appearances were noticed: A triangular, yellowish-red infiltrated and elevated zone, the base of which is turned towards the cornea and is about 7 *mm* wide, has encroached upon the temporal half of the conjunctiva bulbi, within the region of the space between the lids, but has not involved the limbus, although it is quite close to the edge of the cornea. The anterior border of the zone is somewhat everted and the reddish color gradually fades off laterally until the neighboring normal conjunctiva is reached. There are no other abnormalities noticeable in the eye. A large portion of the affected conjunctiva was excised by Prof. Pfluger June 9, 1886, and the wound was closed by sutures. The piece removed remained in absolute alcohol for several days before microscopical examination.

The *epithelium* was seen to be very much thickened, the upper layer consisting of flat epithelium, the middle layer of polyhedral cells, and the deepest of cells of rounder form. In isolated spots almost all of the layers were composed of very attenuated cylindrical epithelium. Adjacent to the epithelium below, was found an infiltrated layer of tissue consisting almost entirely of lymphoid cells, while farther down there was a strip of fibrillar connective tissue peppered over with occasional cells—the substantia propria conjunctivæ. Thereupon followed the loose subconjunctival connective tissue next to the sclerotic. The epithelium throws off cone-like *depressions* which *sink down into the lower parts as broad branching processes.* As in trachoma, upon the surface of the conjunctiva offshoots composed of attenuated cylindrical cells are not infrequent. Glycogen was found in quantity in the flat epithelium and also in the lymphoid cells, especially in the anterior wall of the new growth, directed towards the limbus.

Now I join Vetsch in his query as regards the anatomical appearances which lie before us. What is the prime factor of our disease? Is it the proliferation of the epithelium, or is it the implication of the tunica propria conjunctivæ? I

believe that my preparations enable me to answer with certainty *that spring catarrh is due to the affection of the tunica propria conjunctivæ*, and I am more inclined to agree with *Reymond*, who regards the affection as a connective-tissue neoplasm, than with Vetsch, who believes it to be an epithelial proliferation. Now what has led me to take this view of the matter?

The illustration (Fig. 2) throws light upon this point. It is true that, together with cellular infiltration, we see a marked proliferation of the epithelium. We notice at the same time, however, that the epithelial layer is separated from Bowman's membrane, by a newly formed layer of granulation cells, interspersed with vessels and connective-tissue bands.

Where do these granulation cells come from? Obviously they have penetrated primarily from the neighboring tunica propria conjunctivæ. Inspection of Fig. 2 certainly gives this impression, and Fig. 5 is even more convincing. The latter was derived from the following case.

Cancroid of the Conjunctiva.

(*Plate viii., fig.* 5.)

Margaret Gerber, seventy-two years, received at the Berne ophthalmological clinic April 26, 1886. Patient is feeble-minded and therefore not much previous history is to be obtained. States that she became blind in the affected right eye three years ago, and gives as another cause for her present trouble, a blow of the fist received about three months ago.

Status.—Left eye normal. Right eye: The border of the upper lid is entirely lacking, its place being occupied by a narrow inverted and ulcerated strip of skin. The cutis of the lid is still intact, but feels indurated. The conjunctiva is represented by a mass of tissue composed of alternating cicatrices and ulcers. The process of proliferation has already involved the tarsal cartilage. The conjunc. bulbi is a livid pale-red, peculiarly dry, and surrounds the cornea like a wall. Caruncula and plica semilunaris are much thickened. The cornea shows a diffused opacity, covered with cloudy miliary vesicles. The region of the limbus, especially above and externally and below and internally, is occupied by a

crescentic grayish-red jelly-like mass, about 2 to 3 *mm* wide, lying more towards the cornea. Pupil is contracted, atropine dilates very slightly. Fundus invisible. S = 0. Lower lid apparently normal. April 28, 1886, excision of upper lid and exenteration of the orbital cavity. Lid and globe hardened in Müller's fluid and absolute alcohol.

Microscope.—Cross-sections were made through the thickened jelly-like limbus portion at the lower internal region, including the neighboring cornea, conjunctiva, ciliary body, and iris (Fig. 5), and the following appearances were obtained.

As shown by the illustration, that portion of the tunica propria conjunctivæ (*b*) adjacent to the limbus (*a*) is very much infiltrated with round cells, and numerous vessels are seen in transverse and longitudinal section. The same conditions prevail in the limbus, but there is also marked epithelial proliferation (*c*) in this region. The epithelial cells of the conjunctiva (*d*) send down cones of fair size into the deeper regions, and there are only a moderate number of layers as compared with the remarkable number and size of those of the limbus (*c*) and the neighboring cornea (*e*). The lower part of the body of these cells, excepting those of the lowest rows (1st and 2d), and the cylindrical epithelium (in unstained preparations), is occupied by a homogeneous glistening crescentic-shaped substance. The epithelial layer of the cornea, excepting the peripheral portion, is about normal, as regards thickness, but has a peculiar (low-power) glistening appearance. This round-cell infiltration and development of new vessels extends over the limbus and invests the adjacent corneal region, *the newly formed tissue* (*g*) *thereby pushing apart the epithelial layer* (*e*) *and Bowman's membrane* (*h*). *In places the new tissue forms hillocks which push up the epithelium and encroach upon it* (*i*), thus explaining the above-mentioned miliary vesicles upon the cornea. We may assume, I think, that the new growth in spring catarrh has the same genesis, *i. e.*, from the tunica conj. propria and agree with Reymond *that the growth originates from connective tissue. The round-cell infiltration is primary, followed secondarily by*

epithelial proliferation, as is seen in the above case of cancerous infiltration. Returning to this case I found a large percentage of glycogen in the epithelium of the jelly-like and thickened limbus region and neighboring cells of the cornea, as well as a considerable quantity ***in the changed carcinomatous epidermis of the lid*** (***stratum corneum***) ***and in the larger lanugo hairs.*** The presence of glycogen in these hairs confirms the following extract from my inaugural dissertation: Inspection of a transverse section of the shaft of the hair convinces us of the absence of glycogen in the inner coat, as is also shown by the absence of reaction to the test with iodine. This is not the case, however, with the ***outer coat.*** Here it is seen that its entire thickness, including its layer of cylindrical cells, is stained "wine-red." This reaction seldom extends throughout the entire cell, but when it does so occur, the color is irregularly distributed; usually but one portion of the cell is affected. When the latter is the case the glycogen is met upon the same side in all the cells, and is usually in the form of a crescent, the concavity of which is directed towards the shaft of the hair. Sometimes in addition to these crescents there is also a slight fleck of glycogen covering the remainder of the cell. Many of the hair shafts showed a peculiar deviation from the normal, as regards the inner coat—in the place of the normal membrane of Huxley, a layer filled with fat drops was seen adjacent to the cuticula. Longitudinal sections demonstrate that the glycogen reaction is confined to the lower half of the shaft, and in no case extends as far as the opening of the sebaceous gland into the hair follicle. The cells covering the hair papilla do not contain glycogen. It is often met with in the medullary substance but seldom in the cells of the hair bulb. The cell nucleus here as well as elsewhere showed no trace of glycogen. The color obtained in the hairs, or rather in the outer coat, by this reaction is usually burgundy-red, and not mahogany-brown, as in the epithelium of the epidermis, cornea, and conjunctiva. In my opinion spring catarrh is a chronic eczematous form of disease of the conjunctiva-corneal tissue, and amongst the acute eczematous forms

(phlyctenular) should be classed next to "pannous tissue," as a sort of keratitis fascicularis with which it has much in common, viz.: the slight amount of irritation of the eye, the progression of the colloid tumor (drawing a vascular strand after it) across the cornea, and according to the intensity of the process, the more or less marked cloudiness of the cornea. As our disease mostly occurs in the spring, dust and *insolation* are no doubt causative factors of the "*eczema.*" We might, therefore, regard the so-called "spring catarrh" as an "*eczema solare chronicum conjunctivæ.*" Therapeutic measures accomplish very little, but salves externally (as of plumb. acetic.), and internally arsenic, render the most service, and this would testify in favor of the chronic eczematous nature of the disease. Excision and thermo-cautery, as well as galvano-cautery of the jellified thickened corneal region, do not prevent recurrence. This latter fact indicates that the affection is more deeply seated than the epithelium. The peculiarities of the affection—its return every spring or summer as soon as the intensity of the sun's rays increases—would certainly indicate a dependence of the eczema upon the heat of the sun's rays. The "stadium acmes" of the disease occurs in summer (Vetsch). According to Vetsch and a few of my own observations, the young male is more apt to be attacked by eczema solare conjunctivæ, although Prof. Pflüger treated one case, in a man of seventy-four years (carcinoma was positively excluded).

The sequelæ of the affection are not unimportant, according to Vetsch. In the first place, *corneal opacities* are often left behind, which, apart from the disfigurement produced, are apt to be centrally located, and may cause disturbances of vision; secondly, after the disappearance of the papillæ-like proliferations, the *conj. palp. sup.* is left pale, *atrophic*, and smooth, and the activity of its secretion is affected, thus also implicating the cornea. The glistening hyaline, colorless, and transparent substance met with by us in the *epithelial*, *lymphoid*, and *corneal* cells is without doubt glycogen, as indicated by the following facts: This homogeneous substance showed an indistinct amyloid reaction, upon the

addition of *gentian-* and *methyl-violet*, as suggested by *Beselin*. Those portions containing glycogen were colored a reddish hue (especially under the influence of methyl-violet), while the remaining tissue remained a vivid blue. This slight reddening of course cannot be regarded as characteristic of amyloid, and its *solubility in water and glycerin* is positive evidence of its *not being* that substance. The *mass* in question was also *insoluble in ether and alcohol;* hence it could not have been fat (this point was also noted by *Beselin*).

As regards the iodine reaction, *both glycogen* as well as *amyloid substance are stained wine-red*, but glycogen is usually colored a mahogany-brown. Furthermore, after the addition of sulphuric acid, there was *no* change of color in the masses of iodine-stained glycogen to dark green or blue, as often takes place in many cases of amyloid degeneration. This also confirms *Beselin's* observations. *Water extracts the glycogen from the cells*, so that sections hardened in alcohol, after a certain time, according to their thickness, no longer react to iodine. A section containing glycogen in its cells, after being immersed in water for half an hour, was then treated with iodine, and examined by the microscope. The glycogen of some of the cells had diffused into the neighboring tissues, staining them a light wine-red, while in other cells the crescents above mentioned had been broken up into more or less large drops. Longer exposure to water removed all trace of glycogen. *The saliva changes glycogen into grape sugar*. The gradual disappearance in ten minutes of glycogen from the cells of the outer coat of the hair follicle, under the influence of the saliva, was satisfactorily observed with the microscope. This disappearance was not due to the action of water, as this requires much more time. The *wine-red* or *mahogany-brown* of glycogen, when stained with iodine, *disappears when warmed*, and *returns when the preparation becomes cool again* (*Cl. Bernard* and *Godet*). This I observed very distinctly where glycogen was present in the outer coat of the hair follicle. Furthermore, when I warmed preparations containing glycogen (stained with iodine) I saw the exit of the glycogen from

the cells in large and small drops; subjected to a still greater heat these cells dissolved, and the surrounding tissue being now subjected to the action of glycerine, was colored a diffuse light wine-red.

As mentioned in my inaugural dissertation, *the glycogen* of specimens preserved in glycerine for a long time *is* eventually *dissolved* by it, and after several months there is no response to the iodine reaction in fine microscopical preparations; it may still be observed in thicker specimens. The glycogen remains longest in horny cellular parts, as in the stratum corneum of the epidermis, where the keratin of the cells containing glycogen protects it for a long time against the action of water, glycerine, or saliva. These cells, when treated with iodine, still show a more or less diffused wine-red tinge.

SYSTEMATIC REPORT ON THE PROGRESS OF OPHTHALMOLOGY DURING THE FIRST QUARTER OF THE YEAR 1889.

By H. MAGNUS, Breslau: C. HORSTMANN, Berlin, and A. NIEDEN, Bochum.

WITH THE CO-OPERATION OF

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Sections I.—V. Reviewed by Prof. H. MAGNUS.

I.—GENERAL OPHTHALMOLOGICAL LITERATURE.

a.—TEXT-BOOKS, MONOGRAPHS, TREATISES ON GENERAL, BIBLIOGRAPHICAL, AND HISTORICAL SUBJECTS.

1. Barthélemy. L'examen de la vision devant les conseils de revision et réforme dans la marine et dans l'armée et devant les commissions des chemins de fer. Paris, 1889.

Barthélemy (1) in a book intended for French military physicians discusses the examination of the eyes in the army and navy. The amount of vision deemed necessary for service in the army must equal $\frac{1}{2}$ in the right and $\frac{1}{12}$ in the left eye (myopia being corrected, but not hypermetropia or astigmatism). For the sharpshooters only and the scholars of the school at Châlons the mimimum for the right eye is 1, for the left $\frac{1}{2}$. The acuteness of sight (always without correction of a refractive error) demanded in the navy varies very much; for the scholars of the naval academy it must equal $\frac{5}{6}$ in the right, $\frac{1}{2}$ in the left eye, and color-per-

ception must be normal; for look-out men and helmsmen it must equal 1 in both eyes, no test of color-perception demanded by the regulations, but generally examined; cannoneers, tambours, torpedomen, sharpshooters and ships' boys must have V = 1 in both eyes. For the remainder of the marine the vision demanded varies between $\frac{2}{3}$ and $\frac{1}{4}$ for both eyes. No one is received into the army who has a myopia exceeding 6 D.

2. ALEXANDER. The new ophthalmic institute for the district of Aix-la-Chapelle. *Klin. Monatsbl. f. Augenhk.*, 1889, p. 50.

3. HANSSEN. The ophthalmic clinic at Kiel. *Inaug. Diss.*, Kiel, 1889.

4. JOSTEN. Remarks on the interior arrangements of ophthalmic hospitals. *Klin. Monatsbl. f. Augenhk.*, 1889, p. 106.

5. ROSTOCK. The projected ophthalmic hospital at Rostock. *Klin. Monatsbl. f. Augenhk.*, 1889, p. 58.

6. KOTELMANN. Writing in the middle ages. *Zeitschr. f. Schulgesundheitspflege*, vol. ii., No. 5. Until 1501 the letters stood at right angles to the line, but after that date they assumed a slight inclination to the right, which gradually increased. The paper was so placed that its upper edge was parallel with the upper margin of the desk.

b.—STATISTICAL PAPERS.

7. ALEXANDER. Tenth annual report of the ophthalmic institute for the district of Aix-la-Chapelle, 1889.

8. BALTIMORE. Eleventh annual report of the Presbyterian Eye, Ear, and Throat Charity Hospital, Baltimore, 1888.

9. BROOKLYN. Twentieth annual report of the Brooklyn Eye and Ear Hospital, for 1888.

10. DÜRR. Report for the year 1888. Hanover, 1889.

11. FARAVELLI. La clinica oculistica di Pavia per gli anni scolastici 1886–87, 1887–88. Noti statistici. *Ann. di ottalm.*, vol. xvii., 5, p. 446.

12. GASETTI. La divisione oculistica dell' ospedale civile di Venezia. *Ann. di ottalm.*, vol. xvii., 5, p. 185 (conclusion).

13. HERRNHEISER. Report on the ophthalmic clinic of Prof. Sattler for the year 1888. *Prager med. Wochenschr.*, 1889, Nos. 9–11.

14. KLEIN. Sixth annual report of the Ophthalmic Hospital at Neisse. From Feb. 1, 1888, to Jan. 31, 1889, incl. Neisse, 1889.

15. LAPERSONNE. Statistique de la clinique pour l'année 1887–88. *Extrait du bulletin méd. du Nord*, 1889.

16. MASSACHUSETTS. Sixty-third annual report of the Massachusetts Charitable Eye and Ear Infirmary, 1888.

17. NORSA. Un biennio di clinica oculistica. Sept., 1886, to Sept., 1888. Rome, 1889.

18. SCHREIBER. Sixth annual report of the Magdeburg Ophthalmic Hospital from Jan. 1, to Dec. 31, 1888, incl. Magdeburg, 1889.

19. WIESBADEN. Thirty-third annual report of the Ophthalmic Hospital for the poor at Wiesbaden, 1888. Wiesbaden, 1889.

At AIX-LA-CHAPELLE (7) 2,281 new patients were treated and 266 operations performed. Among them 19 extractions of senile cataract, 5 enucleations, 12 tenotomies, 24 iridectomies, 4 sclerotomies.

In BALTIMORE (8) 5,425 new patients were treated and 1,080 operations performed, the latter, however, including all the minor operative procedures which are generally not counted. Among them 97 extractions; 47 without, 50 with, iridectomy. Enucleations 28, eviscerations 3.

The total number of eye cases treated at the BROOKLYN Eye and Ear Hospital (9) was 4,661. Total number of operations 765, including all the minor ones. Among these there were 18 extractions, 20 iridectomies, and 19 enucleations.

DÜRR (10) treated 2,369 new patients. The conjunctival affections furnished the greatest number (47.7 %), then followed the affections of the accommodation (13.2 %), then the diseases of the cornea (11.3 %), then refractive errors (10.9 %). Operations 148. Number of extractions according to v. Graefe 27, all successful.

At PAVIA (11) at the clinic conducted by Rampoldi, 2,642 new patients were treated from 1886 to 1888; in the in-door department, 662. Operations 438.

SATTLER (13) treated 2,774 new patients, 62.79 % of whom were males, 37.21 % females. Major operations 770, among them 170 extractions according to v. Graefe. Iridectomy with artificial ripening 20. In 98.32 % of the extractions the result was satisfactory, $V = \frac{6}{60}$ at least.

KLEIN (14) treated 1,284 new patients. Operations 175. Extractions 35.

LAPERSONNE (15) treated 884 eye-patients, 96 of whom were admitted to the in-door department. Among 124 operations there were 23 extractions. He discusses at length three cases of "dyscrasial uveitis," the etiology of which was not clear. He operated on a case of ptosis in a manner similar to that described by Panas (*cfr. Arch. d'opht.*, vol. vi., 1, p. 1). He, however, gave the flap the shape of a trapezoid. Besides the sutures with which Panas fixes the flap above, he also inserts two or three deep ones, which pass from the upper edge of the tarsus to the forehead and remain in position for three weeks. Panas mentions these deep sutures in his paper, but never has made use of them. The result was very good. MARCKWORT.

In the Massachusetts Eye and Ear Infirmary (16) there were treated in 1888, 9,031 eye-patients. Among the operations there were 97 extractions according to v. Graefe, 17 by modified flap without iridectomy, and 12 cases of suction, all of which are carefully tabulated by Dr. Bradford. There were two losses in the extractions, none in the simple. The eye-surgeons are Drs. Graefe, Derby, Shaw, Sprague, Jeffries, Willard, and Bradford.

NORSA (17) treated 1,262 new patients. Conjunctival affections showed the highest percentage (30.32 %), the affections of the sclera the lowest (0.07 %). Extractions 12. A photographic plate is added.

SCHREIBER (18) treated 1,900 new patients and performed 212 operations, 22 extirpations of the lachrymal sac, 18 extractions, 11 exenterations, 10 enucleations.

In WIESBADEN (19) 2,365 new patients were treated and 560 operations performed. Extractions without the capsule 65, all successful; 11 with the capsule, also successful.

II.—GENERAL THERAPEUTICS, DIAGNOSIS, AND PATHOLOGY.

a.—GENERAL THERAPEUTICS.

20. ANDREWS. Enucleation of the eyeball in purulent panophthalmitis. *N. Y. Med. Journ.*, Dec. 29, 1888.

21. ANAGNOSTAKIS. The antiseptics of the ancients. Athens, 1889.

22. NAGA. Exenteratio bulbi. *Geneeskundig Tijdschrift voor Nederlandsch Indie*, Deel xxviii, 5, p. 619.

23. PFALZ. The application of massage in ophthalmology. *Deutsche med. Wochenschr.*, 1889, No. 2; *Tageblatt d.* 61. *Naturforscher-Versamml. in Köln.*

24. VAN DER SPIL. De bepaling van astigmatisme met den ophthalmometer van Javal-Schjötz. *Weekblad van het Nederlandsch Tijdschrift voor Geneeskunde*, vol. i., p. 358.

ANDREWS (20) enucleated twelve eyeballs in a state of panophthalmitis, without any unfavorable symptoms during the process of healing. He presents the statistics of thirty cases of fatal issue after enucleation, and cites the views of a large number of authorities on this subject. He does not deny the danger, but thinks that it can be diminished by observing strict antiseptic precautions during the operation and by subsequent careful drainage.

PFALZ (23) highly recommends massage. He employs it by applying to the surface of the eyeball a salve, the nature of which will vary with the disease, and then rubs with the eyeball in a radiating or circular direction. The physiological action of massage consists in stimulation of the circulation, in the absorption of pathological products, in irritation of the nerves, and in the freeing of the nerves from the compression exercised upon them by the pressure of pathological products. Massage is especially adapted for those parts of the eye which are directly accessible, but the iris and ciliary body can also be made subject to it. Corneal opacities, the remnants of previous inflammations, are especially amenable to this method of treatment. Also parenchymatous keratitis, but only in the later stage. It is also applicable in cases of chronic pustulous conjunctival affections, vernal catarrh, dry catarrh, chronic iritis, and blepharitis marginalis.

VAN DER SPIL (24) reports that the ophthalmometer of Javal-Schjötz is used to great advantage at the clinic of Prof. Snellen. As the curvature of the cornea changes after every sclerotomy or keratotomy, the curvature of that meridian diminishing which is perpendicular to the corneal or scleral wound, the curvature of the cornea is always ascertained before the operation, in order to determine the direction of the corneal wound, all other indications having been satisfied.

b.—GENERAL DIAGNOSIS.

25. BURNETT. Models constructed by Mr. C. J. Prentice for demonstrating refraction by crossed cylinders. *Trans. Amer. Ophth. Soc.*, 1888.

26. NIEDEN. Test-types for determining the acuteness of distant vision. New series. Wiesbaden, 1889. Very practical.

27. SNELLEN, Jr. Skiascopy. *Weekblad van het Nederlandsch Tijdschrift voor Geneeskunde*, vol. i., p. 153. A convex mirror with a short focus he considers better than a plane or a concave mirror.

c.—GENERAL PATHOLOGY.

28. KOLINSKY. Contribution to the knowledge of the action of naphthaline on the eye, and on the so-called naphthaline-extract. *Wjestnik Ophth.*, Jan.–Feb., 1889; *v. Graefe's Arch. f. Ophth.*, vol. xxxv., 2.

29. MASON. State of the eye as a sign of death. *Brit. Med. Journ.*, Feb., 1889, p. 410.

The naphthaline (28) was given to the animals experimented upon (rabbits, guinea-pigs, dogs) in form of a mixtura agitanda (prepared with gum-arabic), or dissolved in oil, or in gaseous form by inhalation. The largest dose was one grm. to one kilogr. animal daily, or at greater intervals. The rapidity and kind of poisonous changes noticeable in the eye depends upon the species of animal, the manner and quantity in which the naphthaline is given, and the frequency of the doses. Solutions of oil produce results more rapidly (the synchisis scintillans described by Panas, however, is rarely observed). Dogs are less susceptible than rabbits; guinea-pigs are the most sensitive. The changes in the lens are secondary. They are the consequences of the pathological changes in the eye due to the disturbed nutrition. At first numerous extravasations are observed in the ciliary region, in the choroid, the ciliary processes, the sclera. The blood-vessels of the choroid are dilated. The extravasations spread centripetally. Soon the white spots described by Panas appear, which increase in size, become confluent, reach the optic nerve. The retina becomes detached. The whole fundus is soon covered with membranous formations, which extend through the vitreous and attach themselves to the lens. In rabbits to which the mixtura agitanda had been given, small, shining dots appear (synchisis scintillans) before the white dots are noticed in the retina; they adhere to the retina, or to the membranous opacities, or to the hyaloid membrane, or to the anterior surface of the lens, or to the cornea; KOLINSKY, however, never saw them free in the vitreous. The microscope shows that the principal changes have

taken place in the walls of the blood-vessels, especially in the chorioc-apillaris. The walls of the blood-vessels frequently have been destroyed, the escaping blood first spreads out between the choroid and the layer of rods and cones separates the pigment-layer from the retina and is the primary cause of the subsequent detachment of the retina. The retina is œdematous, partially destroyed, infiltrated with masses of detritus. In some cases the retina and choroid are here and there united, forming a glassy mass (like the mucous membrane of the stomach). The shining dots consist of crystals, in which Kolinsky found calcium and phosphorus. They do not contain any sulphate of calcium. The formation of cataract is a secondary phenomenon which is not always observed. It is preceded by an irregularity in the curvature of the lens, due to the formation of several layers of new-formed, variously shaped cells under the anterior capsule and their products of disintegration. The surface of the lens in consequence appears wavy. Disintegration and hyaline degeneration of the lens follow. Naphthaline acts differently even on different animals of the same species, thus explaining the contradictory results of Panas and Hess. The changes in the eye of course only form a part of the changes which take place throughout the whole body, which Kolinsky attributes principally to changes in the blood, especially in the red blood corpuscles.

HIRSCHMANN.

III.—INSTRUMENTS AND REMEDIES.

a.—REMEDIES.

30. ALT. The value of creoline in ophthalmic practice. *Amer. Journ. Ophth.*, January, 1889.

31. HOLLAWAY. Idiosyncrasy to atropine. *Brit. Med. Journ.*, 1889, p. 127.

32. REICH. A remarkable action of atropine. *Centralb. f. prakt. Augenhk.*, 1889, p. 111.

33. STADERINI. Sugli effetti anestetici del veleno del raspo nell' occhio. *Ann. di ottalm.*, vol. xvii., 5, p. 424.

ALT (30) has given creoline a trial, and recommends it in parenchymatous keratitis, as a disinfectant for surgical instruments, and as a hæmostatic. BURNETT.

REICH (32) saw profuse nasal hemorrhage follow the instillation of atropine (1 : 120)) on account of progressive myopia in a boy aged seventeen. Duboisine had the same effect.

STADERINI (33) has made further investigations on the anæsthetic effect of toad-poison, and has shown that a few drops of a 1-per-cent. watery solution of the dried secretion of bufo vulgaris, introduced into the conjunctival sac of dogs or rabbits, at first cause a little pain, then slight irritation of the eye, and about fifteen minutes later complete anæsthesia of the cornea and conjunctiva. The insensibility continues for four or five hours; the conjunctiva and cornea may be pierced, yet the animal does not react. The deeper parts—for instance, the insertions of the muscles — do not lose their sensibility until a few drops have been injected under the conjunctiva near them. The muscles of frogs which have lain for ten minutes in the solution completely lose their contractility, even strong currents having no effect on them. From this direct action on the fibres of muscles the author explains the disturbances of motility of the lids and ocular muscles of the patient who received the juice into her eye directly from the animal; she came to the clinic on account of the pain, which at first was severe, and thus gave the incentive to the subsequent experiments. The mucous membrane of the tongue is affected in the same manner as the conjunctiva. DANTONE.

b.—INSTRUMENTS.

34. BETTREMIEUX. Une modification du couteau à cataracte (Lame à dos rectangulaire). *Arch. d'opht.*, 1889, vol. xi., 1, p. 79.

35. JACKSON, BURNETT, NOYES. Report of the committee on the designation of prisms by the degree of refractive power. *Trans. Amer. Ophth. Soc.*, 1888.

36. SCHWEIGGER. The electric ophthalmoscope. Lecture delivered before the Physiological Society at Berlin. *Arch. f. Physiol.*, 1889.

37. WALKER. A new eye-speculum. *Lancet*, Feb., 1889.

BETTREMIEUX (34) had Luer make a cataract-knife for extraction without iridectomy. Its object is to prevent contact with the iris during the act of cutting, which is most easily accomplished with a broad blade with a thick back. In order to preserve, however, the easy handling of the Graefe knife the author has not altered its general size and shape, but has given its cross-section the shape of a right-angled triangle (otherwise that of an isosceles). On entering the anterior chamber with the knife, the surface forming the long side of the right angle is turned toward the

cornea. There must therefore be a special knife for both eyes. To avoid mistakes the side turned toward the operator is provided with a mark. v. MITTELSTÄDT.

THE REPORT OF THE COMMITTEE (35) which was adopted by the Society was, (1) that prisms ought to be designated by the number of degrees of minimum deviation they produce; (2) where intervals of less than one degree are desired half and quarter degrees should be used; (3) to indicate that degrees of deviation are meant the letter *d* should be added—thus: prism 2 ° d will indicate a prism which produces a minimum deviation of 2 °. BURNETT.

SCHWEIGGER (36) shows that for the examination by the indirect method it is sufficient to illuminate a part of the pupillary area of the eye to be examined with a small incandescent light, shaded above and behind, and held before the eye to be looked at. For the examination on the upright image this method, however, is insufficient. Schweigger also utilizes the direct illumination of the eye in the construction of a binocular ophthalmoscope for the indirect method. He has also constructed an apparatus, fitted with an electric light, which makes it possible to determine the exact position of the far point at which the inverted image is formed in highly myopic eyes.

IV.—ANATOMY.

38. DUVAL and KALT. Des yeux pineaux multiples chez l'orvet. *Sem. méd.*, 1889, No. 7.

39. HESS. Description of the eye of talpa europæa, and of proteus anguineus. *v. Graefe's Arch. f. Ophth.*, vol. xxxv., 1.

40. PERLIA. A new optic nerve-centre in the chicken. From investigations at Senckenberg's Institute. *v. Graefe's Arch. f. Ophth.*, vol. xxxv., 1.

HESS (39) concludes from careful microscopic examinations that the eye of the mole, in spite of its remarkable smallness, is well adapted for the observation of the outer world. It is even very probable that the sight of this animal is much better than has hitherto been assumed. Hess denies that the eye of the mole is myopic, as maintained by others. All the accessory organs of the eye are well developed. The eye of proteus, on the other hand, is not so much a stunted, but rather an imperfectly developed one, which is probably able merely to distinguish between light and darkness.

PERLIA (40) describes a bundle which leaves the optic tractus on the median side, and passes on by itself. It remains close below the dorsal surface of the cerebral trunk at the medial upper end of the optic nerve-fibre layer of the optic lobe, on the boundary between the latter and the medial cerebral lobe. After passing laterally from the nuclei of the oculomotor nerve it ends in a large nucleus beside that of the trochlearis nerve.

b.—MALFORMATIONS.

41. VAN DUYSE. Cryptophthalmus. *Ann. d'ocul.*, v. ci., p. 69.

VAN DUYSE (41) observed a case of cryptophthalmus resembling that described by Manz (*cf. Graefe-Saemisch*, vol. ii., p. 103), in a child three weeks old.

c.—OPTIC NERVE, RETINA, AND CENTRAL ORGANS.

42. NAUMOND. The question of the development of the macula lutea in the human retina. *Wjestnik. Oph.*, 1889, No. 2.

From a series of not yet finished investigations of the eyes of embryos and new-born children, NAUMOND (42) draws the following conclusions: 1. The macula already exists in the seven months' embryo. 2. The thickening at the region of the macula found in the four months' embryo and the greater development of the pigment epithelium at this point speak against the view that there is an opening here at an early period of embryonic life (Manz). 3. The differentiation of the retinal layers and the formation of the layer of rods and cones begin from the macula lutea, and not from the papilla (Kostenitsch). 4. The formation of the yellow spot is the beginning, and not the end, of the development of the retina. HIRSCHMANN.

d.—BLOOD-VESSELS OF THE EYES.

43. GOLDZIEHER. A so-called precorneal network of blood-vessels in the human eye. *Wiener med. Wochenschr.*, 1888, No. 30.

44. RUMSCHEWITSCH. On the anastomoses of the posterior ciliary blood-vessels with those of the optic nerve and retina. *Klin. Monatsbl. f. Augenhk.*, 1889, p. 41.

GOLDZIEHER (43) publishes a case which supports the assumption of an embryonic precorneal network of blood-vessels, and expresses the opinion that it may be preserved in some persons into childhood, either partially or entirely, and so form the basis of a later inflammatory mesh of blood-vessels.

RUMSCHEWITSCH (44) shows that besides the capillary anastomoses of Leber, other communications may exist between choroidal and retinal systems of blood-vessels, retinal venous vessels of the second magnitude forming the connecting links.

V.—PHYSIOLOGY.

a.—GENERAL.

45. FEILCHENFELD. On some reflexes originating from the surface of the conjunctiva and cornea. *Zeh. klin. Monatsbl.*, 1889, p. 8.

46. FICK. On the factors governing the convergence of the visual axes. *Correspondenzbl. f. Schweizer Aerzte*, 1889.

47. GOULD. Is the electric light injurious to the eyes? *Med. News*, Dec., 1888.

48. HELMHOLTZ, H. v. Handbook of Physiological Optics. 4. and 5. numbers. Second edition.

49. JACKSON, EDW. Symmetrical aberration of the eye. *Trans. Amer. Ophth. Soc.*, 1888.

50. LEPLAT. Nouvelles recherches sur la circulation du liquide intra-oculaire. *Ann. d'ocul.*, vol. ci., p. 123.

51. MAKLAKOFF. L'influence de la lumière voltaïque sur les téguments du corps humain. (L'insolation électrique). *Arch. d'opht.*, vol. ix., No. 2.

52. VON MARTINI. The position of the double images in binocular vision. Communications of the Thurgau Society of Naturalists. No. 8. Rev. in *Zeh. klin. Monatsbl. f. Augenhk.*, 1889, p. 100.

53. STRAUB. Over het evennicht der weefsel en vloeistof Spanningen in het oog. *Weekblad van het Nederlandsch Tijdschrift voor Geneeskunder*, vol. i., 1889.

When a healthy pair of eyes fixedly regards a point, the following conditions unite, according to FICK, (46), in bringing about the crossing of the visual axes at the point of fixation: 1. The tendency to binocular single vision; 2. The tendency to a certain amount of convergence which accompanies every accommodative effort; 3. A conception of the position of the point of fixation in space, and a correct position of each eye resulting therefrom independently of the other, a factor entirely distinct from the other two. In healthy eyes, factors 1 and 2 are sufficient to secure the

proper degree of convergence, so that the third is not called into play at all. If, however, the muscular equilibrium is disturbed and a tendency to divergence develops, the third factor is called into requisition and by practice may become so powerful that it is able to convert the acquired divergence into the desired convergence.

GOULD (47) believes that for the purposes of general illumination the electric- is undoubtedly superior to gas-light. In cases in which it is injurious this is due to the intensity, and not to the preponderance of the ultra-violet rays. The immediate symptoms, according to Gould, are temporary paralysis of the retina, blepharospasm, central scotomata, chromatopsia, after-images; then photophobia, lachrymation, pain, congestion, etc. The treatment consists in the installation of cocaine and atropine and the application of hot and cold compresses. Prognosis good.

BURNETT.

The 4 and 5 numbers of the famous book of HELMHOLTZ (48) treat of the visual perceptions, color-perception, and of the laws in regard to the intensity of the perception of light.

JACKSON (49) has determined by examination of the eye, principally by the shadow-test, that there is a symmetrical aberration such that the rays of an incident pencil piercing the cornea in the same meridian, but at different distances from the axial ray, intersect the latter at different distances behind the cornea, while rays piercing different meridians of the cornea, but at the same distance from the axial ray, intersect it at the same point. The aberration may be positive or negative. BURNETT.

LEPLAT (50) has made some new and very interesting experiments on the entrance and exit of the intraocular liquid, and comes to the conclusion that the fluid secreted by the ciliary body and to a very small extent by the iris, leaves the eyeball through the anterior chamber, and that the portion which passes through the papilla is very small. He finds with Priestley-Smith that the ratio of the amount of liquid escaping by these exits is as 1 (through the papilla) to 50 (through the anterior chamber). According to Leplat, the amount of fluid which leaves the anterior chamber of rabbits is about 20 to 25 mgrm. in five minutes. MARCKWORT.

MAKLAKOFF (51) studied on himself and others in an iron foundry the effect upon the eye and skin of an electric flame used there in welding iron. Soon after the beginning of the experi-

ment: a prickling sensation in the skin of the face and in the eyes; three to four hours later: coryza, lachrymation, a dry irritant cough, swelling and great painfulness of the skin of the face. About ten hours after the beginning of the experiment the symptoms are most severe. There is swelling of the lids and ocular conjunctiva in the space of the palpebral fissure, very intense photophobia, and a very disagreeable sensation as of the presence of a foreign body with lachrymation and sensibility of the eye to pressure. The author also found increased tension. With the appearance of a slight muco-purulent discharge the symptoms gradually subside. At this point cocaine acts, which before only increased the pain. It is also found now that the palpebral conjunctiva is not affected at all. Desquamation of the epidermis follows, and for weeks a pigmentation of the skin remains. The author attributes the affection to hyperæsthesia of the parts of the skin and eyes struck by the light, combined with hyperæmia and œdema, which are produced by the chemical action of the rays of light. This action is prevented by the interposition of a veil of yellow wax-taffeta. The author leaves it undecided when other colors have the same neutralizing effect, but for yellow he considers it proven. Further investigations on this point, however, are necessary. The influence of the electric light on different parts of the skin is still a wide field for investigation. The author has constructed a veil for the head and neck of the workmen, who perform the labor in question with the greatest reluctance. A plate of yellow glass is also inserted in the veil. For cutting off the rays of light a glass made up of green and red has been found most serviceable. v. MITTELSTÄDT.

STRAUB (53) confirms the opinion expressed by Donders twenty-five years ago, that the choroid bears part of the intraocular pressure by means of its muscular fibres. The action of the sclera consists in neutralizing the alternate pressure of the muscles, which takes place during fixation and rest, and in changing the direction of the visual line and the point of convergence. The forces which act upon the cornea are the ciliary muscle, the chord of which is Descemet's membrane, the straight muscles of the eye, and the tension exerted by the lids.

b.—RETINA.

54. TREITEL. On the sense of light at the periphery of the retina. *v. Graefe's Arch. f. Ophth.*, vol. XXXV., 1, p. 50.

TREITEL (54) finds that, the conditions being the same, the

ratio between the peripheric and central sense of light changes materially when a diminished illumination takes the place of daylight. While in daylight the peripheric power of perception is about one tenth of the central, at a distance of 30–40° from the macula, this difference is reduced about one half when the intensity is reduced to a certain point. This change takes place mainly at the expense of the central sense of light. The latter is diminished to about one twelfth, while the peripheric is decreased about one half.

c.—COLORS.

55. HOLMGREN. Studies on the elementary color-perceptions. *Skandinav. Arch. f. Physiol.*, 1889, vol. i., 1.

56. OLIVER, C. A. Description of a series of tests for the detection and determination of subnormal color-perception (color-blindness), designed for use in railway service. *Trans. Amer. Ophth. Soc.*, 1888.

57. RICCHI. La facolta visiva nel personale delle Ferrovie Meridionali. *Boll. d'ocul.*, vol. xi., 5 and 6.

58. SAMUILOW. The question of the exhaustion of the retina by various colors. *Wjestnik Ophth.*, 1889, No. 2.

59. SIMI. Eritropsia. *Boll. d'ocul.*, vol. xi., 5.

HOLMGREN (55), being a faithful supporter of the theory of Young-Helmholtz, has endeavored to demonstrate experimentally the different action of the individual retinal elements in regard to color-perception. In this paper, which simply is an introduction to his interesting series of experiments, Holmgren explains how he tries to excite separately the individual retinal elements. He describes the different methods and instruments which he employed for this purpose, and the incidental phenomena accompanying these investigations.

OLIVER'S (56) method consists : (1) in the selection and registry of a definite number of loose wools from twenty-three pure and confusion match-skeins thrown upon a dead black surface at one metre distance ; (2) in the selection and registry of the same number of similar reflected colors under various intensities of diffuse daylight stimulus, placed at distances requisite for safety ; (3) in the selection and registry of transmitted color under various intensities of artificial light stimulus, placed at distances requisite for safety. The best manner of carrying these ideas out is described in detail. BURNETT.

RICCHI (57) reports that among 13,716 employés of the Italian Ferrovie Meridionali who were examined in 1887 there were 25.26 % ametropes (only 6.72 % hyperopes?—The REV.). Of the total number 96.55 % had normal color-perception; in 0.85 % it was feebly, in 1.61 % very feebly, developed. The percentage of red-green blind was 1.19 %. DANTONE.

SAMUILOW (58) comes to the following conclusions: 1. Red light tires the retina most, green less, blue the least. This difference is most marked at the fovea centralis. 2. The periodic variations while the negative after-images last are an accidental phenomenon. 3. The duration of the central after-images increases for colors of a weak or moderate intensity with the length of time during which the retinal irritation lasts. 4. The peripheric negative after-images are not perceived as long as the central one. HIRSCHMANN.

SIMI (59) observed a patient who, during a congestive attack of the fundus (haziness of the vitreous), saw all the strongly illuminated points of an object in a reddish light. This condition persevered after the congestive attack had ceased, and sight and color-perception had again become normal, and did not disappear until the eyes had been compelled to work for two hours daily while exposed to reddish gaslight, so that the retina was fatigued with red. The author again stirs up the question of the therapeutic use of colored light. DANTONE.

Sections VI.–XI. reviewed by DR. HORSTMANN.

VI.—ANOMALIES OF REFRACTION AND ACCOMMODATION.

60. ANGELL, H. C. Atropine in the correction of optical defects by glasses. *Journ. Ophth., Otol., and Laryng.*, Jan., 1889.

61. BAER, A. N. On the orbital index in the different refractive conditions between the ages of ten and nineteen. *Inaug. Diss.*, Munich, 1889.

62. BURNETT, S. M. An analysis of the refraction of 576 healthy human corneæ examined with the ophthalmometer of Javal and Schjötz. *Trans. Amer. Ophth. Soc.*, 1888.

63. BURNETT, S. M. A disc of lenses to be used in determining refraction by means of skiascopy. *Trans. Amer. Ophth. Soc.*, 1889.

64. CHAUVEL. Sur la myopie et les rapports avec l'astigmatisme. *Soc. d'opht. de Paris*, Feb. 5, 1889.

65. EMERSON, J. B. A case of progressive hyperopic astigmatism. *Trans. Amer. Ophth. Soc.*, 1888.

66. FEILCHENFELD, W. Statistics in regard to the refractive changes in young people and adults. *v. Graefe's Arch. f. Ophth.*, vol. xxxv., 1, p. 113.

67. LOISEAU. Contribution à l'astigmométrie et notation de l'astigmatisme. *Ann. d'ocul.*, vol. ci., p. 99. Recommends the notation described by Knapp and Landolt.

68. MACNAMARA, N. C. Abstract of clinical lectures on the use of glasses in hypermetropic children. *Brit. Med. Journ.*, Feb., 1889, p. 341.

69. NIENIMIN. On the difference in the degree of myopia and hypermetropia in determining them separately for each eye, or for both simultaneously. *Wjestnik Ophth.*, 1889, No. 1, p. 67.

70. RANDALL, B. A. The curvilinear reflection of Weiss as a prodromal sign of myopia. *Med. News*, 1889, No. 6, p. 152. *Zehklin. Monatsbl. f. Augenhk.*, vol. xxvii., p. 176.

71. SCHMIDT-RIMPLER, H. Myopia and its relation to the formation of the orbit. *v. Graefe's Arch. f. Ophth.*, vol. xxxv. 1, p. 200.

72. SCHNELLER, H. On changes in the shape of the eyes under muscular pressure. *v. Graefe's Arch. f. Ophth.*, vol. xxxv., 1, p. 76.

ANGELL (60) thinks that a routine use of atropine unnecessary in the determination of refraction. He thinks that the true refraction is almost invariably revealed by the direct method of ophthalmoscopic examination. BURNETT.

BAER (61) opposes the theory lately advanced by Stilling that the entrance to the orbit is relatively lower in myopes. From his examination of the scholars of the Mannheim high-school he concludes that this theory of Stilling is untenable, even when only the higher classes are taken into consideration. The orbit changes but little in its vertical diameter during the time of the most rapid growth of the body, while between the ages of fourteen and twenty it becomes considerably broader.

BURNETT (62) has found as the result of the examination of 576 human corneæ with Javal's ophthalmometer, that the corneal refraction by no means indicates the general refractive condition of the eye; that astigmatism according to the rule is almost always corneal, and that the simple forms of astigmatism predominate

over the compound forms. On the other hand, astigmatism against the rule is nearly always lenticular, and that in some instances this form of astigmatism is due to an oblique position of the lens. The average corneal refraction was found to be between 43 and 45 D. For the determination of astigmatism Javal's instrument is most valuable. BURNETT.

BURNETT (63) exhibited a hard-rubber disc, 12 inches in diameter, containing 23 lenses at its periphery, each 3 *cm* in diameter. This was attached to a vertical rod, in such a manner that it could be moved up and down to adjust it to the height of the eye to be examined. The disc can be rotated in front of the eye, bringing each lens in succession before it, either by the patient or by the surgeon. BURNETT.

CHAUVEL (64) reports on a paper of Martin, and in opposition to him comes to the following conclusions: 1. Corneal astigmatism is of more frequent occurrence and of a higher degree in hypermetropes than in myopes. 2. There is no connection between astigmatism on the one side and posterior staphyloma and myopia on the other. 3. The majority of persons with astigmatism resulting from corneal opacities are either hypermetropes or emmetropes, and not myopes. 4. The inclination of the principal meridians of astigmatism ordinarily has no influence on the position of the choroidal ectasia. MARCKWORT.

EMERSON (65) reports a case of a boy of twelve, whose astigmatism increased (under long-continued use of atropine) from $+\frac{1}{60}$ 180° through various changes of axis and gradually increasing numbers to $+\frac{1}{7}$ 165° R, and $+\frac{1}{18}$ 160° L. With these glasses, $V = \frac{20}{40}$ and $\frac{20}{60}$. BURNETT.

FEILCHENFELD (66) finds that in the great majority of young people living in cities, the refractive condition increases. This increase is most marked in myopia, as it amounts from 1 to 2.5 and even 4.5 D, not considering, however, malignant myopia. Sometimes, however, the refraction remains unchanged, and may even decrease in youth. The change in the refractive condition of the two eyes may not be the same; loss of an eye seems to have no influence on the change of refraction. In adults the eyes usually do not undergo any further change when full growth has been attained; a decrease frequently occurs, but also an increase in all refractive conditions. The development of cataract sometimes accompanies the refractive increase, but seems to have no definite influence on the latter.

MACNAMARA (68) believes that in cases of hypermetropia in children, without strabismus, convex glasses ought not to be worn for distance, as this delays or prevents the development of the eye, and interferes with the change towards emmetropia, which is the natural tendency in a very large proportion of cases. An example is given which is not very striking. WERNER.

NIENIMIN (69) finds that in the majority of cases the myopia is of a lower, in hypermetropia however of a higher, degree when a binocular instead of a monocular determination is made. This difference is sometimes apparent even under atropine, even when before its use no difference was found. HIRSCHMANN.

RANDALL (70) does not deny the existence of the curvilinear reflection near the border of the optic-nerve entrance, on which Weiss lays stress and importance as a cause and antecedent to the development of myopia. He has seen it, but does not believe, from a careful examination of a number of cases, that it has any important bearing on the production of myopia.

BURNETT.

SCHMIDT-RIMPLER (71) also opposes the theory of Stilling. He measured the entrance to the orbit in 1,299 eyes of scholars, and determined the orbital index. In emmetropic and hypermetropic eyes the average was 94.4; in myopic, 94.5. He also found that the orbital index in eyes which had become near-sighted was 94.4; in those the refraction of which had remained unchanged, 94.1. A small low orbit cannot be the cause of myopia, and the configuration of the orbit has no influence on the development of myopia. The cause is found in excessive near-work.

SCHNELLER (72) found that under physiological conditions the eyeball does not offer a rigid resistance to the muscular pressure acting upon it. Changes take place at the posterior pole and at the corneal margin, the circle of which becomes larger, so that the cornea becomes flatter. The yielding of the posterior parts of the sclera must give rise to further changes when it lasts long and is frequently and energetically repeated. The sclera is displaced at the posterior pole and becomes thinner, causing a disturbance of nutrition, which becomes permanent when the intervening time is not sufficient to re-establish the equilibrium of nutrition.

VII.—LIDS.

73. BERRY. Note on a congenital defect of the lower lid. *Ophth. Hosp. Rep.*, vol. xii., 3, p. 235.

74. Byers. Xanthelasma palpebrarum. *Brit. Med. Journ.*, Feb., 1889, p. 306.

75. Chodin, A. On the cure of cicatricial ectropium by transplantation of mucous membrane. *Wjestnik Ophth.*, 1889, No. 1, p. 67.

76. v. Hippel. On plastic operations on the lids. *Deutsche med. Wochenschr.*, 1889, No. 10.

77. Koller, Karl. Blepharospasm. *Trans. Amer. Oph. Soc.*, 1888.

78. Ray, J. M. Removal of chalazia according to Dr. Agnew. *Amer. Journ. Ophth.*, 1889, No. 9.

79. Schreiber, R. Case of cancer of the lids. *Deutsche med. Zeitung*, 1889, No. 13.

80. Tilley, R. A case of atrophy of the supercilia and cilia, associated with atrophy of all the finger-nails, of congenital origin. *Journ. Amer. Med. Assoc.*, Jan. 12, 1889.

81. Vialet. Un nouveau procédé de greffe cutanée en ophtalmologie. La méthode de Thiersch et ses indications en chirurgie oculaire. *Arch. d'opht.*, vol. xi., 1, p. 71.

82. Wallenberg, Th. The dermoid tumors of the eye. *Inaug. Diss.*, Königsberg, 1889.

Berry (73) describes a defect, similar to a badly united cut, occurring in the lower lid of a girl, whose mother exhibited the same condition on both sides. Drawings of both patients accompany the paper. The mother and one of the sons had hare-lip.

Werner.

Byers (74) observed xanthelasma palpebrarum in the lower lids of a woman, who was diabetic and suffered from chronic disease of the uterine cervix.

Chodin (75) cured cicatricial ectropium by the transplantation of mucous membrane, and subsequently saw even the curvature of the tarsus disappear.

v. Hippel (76) proposes to modify the operation of Jaesche-Arlt by excising a fold of skin 4 *mm* wide extending over the whole length of the lid, after the intermarginal incision has been made, and transplanting this piece of skin upon the free edge of the tarsus, after the wound in the lid has been closed. In ectropium of the lower lid after caries of the orbital margin, Hippel detaches the lid from the bone-scar, performs tarsorraphy, circumcises the periosteum at the edge of the scar, detaches it with the elevator,

and unites the edges of the periosteal wound with sutures. Then he undermines the edge of the wound in the skin and closes it with sutures.

KOLLER (77) has found that blepharospasm is most frequently produced by a fissure at the outer canthus, sometimes at the inner canthus, of the lids. In treatment he stretches the skin so as to lay the fissure bare and cauterizes it with bluestone. BURNETT.

RAY (78) operates for chalazia in the following manner: cocaine is instilled, and is injected through the ducts of Meibom's glands into the cyst. The latter is then opened by an incision at the intermarginal edge of the lid and evacuated with a sharp spoon. BURNETT.

TILLEY'S (80) patient was a girl of seventeen, in whom there was an atrophic condition of the hair of the eyebrows and lids. They were very short ($\frac{1}{8}$ in. in length), and appeared as if they had been burned off. A younger brother was similarly affected. The father also was said to be affected in the same way. The finger-nails of all were in a condition of dystrophy. There was no indication or history of syphilitic origin. BURNETT.

VIALET (81) describes a case of blepharoplasty performed by Landolt on account of epithelioma involving the whole lower lid. After removal of the neoplasm and the greater part of the conjunctiva of the lid the defect, $2\frac{1}{2}$ *cm* high and 4 *cm* wide, was covered with a flap of similar shape, which extended from the base of the temple to within 2 *cm* of the commissure of the lips. To the bare surface thus exposed four very thin patches were transplanted, cut from the skin of the thigh, and 2 *cm* wide and 4 *cm* long; they were kept in position with a compressive bandage. After the lapse of forty-eight hours the patches were of a rosy-red color, and six days later had regained their sensibility, which the flap covering the palpebral defect did not recover until several days later. After ten days all the patches had taken firm hold and the cosmetic result was excellent. V. MITTELSTÄDT.

VIII.—LACHRYMAL APPARATUS.

83. SOLOMON, T. V. Excision of the lachrymal gland in cases of epiphora, in which severe nervous shock attends its treatment by dilatation. *The Lancet*, Feb., 1889, p. 375.

84. VALUDE, E. Essais de tuberculisation expérimentale du sac lacrymal. *Arch. d'opht.*, vol. ix., 2, p. 165.

SOLOMON (83) relates the case of a lady in whom he excised

the lachrymal gland for persistent epiphora, as she could not bear the shock produced by the use of probes. WERNER.

In a former and in the present series of experiments VALUDE (84) failed in transmitting tuberculosis to the uninjured conjunctiva and the lachrymal gland, and even by inoculation he succeeded only once, and that only temporarily. Valude thinks that the tears remove the infectious material, or that their chemical composition or the presence of other bacilli destroys the virulence of the tubercle bacilli. V. MITTELSTÄDT.

IX.—MUSCLES AND NERVES.

85. EPERON. De la correction opératoire des déviations oculaires verticales d'origine paralytique, en particulier par l'avancement musculaire. *Arch. d'opht.*, vol. ix., 2, p. 115.

86. HADDEN. Case of muscular atrophy with ophthalmoplegia externa. *Brit. Med. Journ.*, 1889, p. 246.

87. HOWARD, R. P. Case of bilateral ophthalmoplegia externa and interna associated with tabes dorsalis, bulbar paralysis, and loss of vision and hearing. *Amer. Journ. Med. Sci.*, March, 1889.

88. STERLING, C. F. Prisms *versus* tenotomy. *Journ. Ophth., Otol., and Laryng.*, June, 1889.

89. STEVENS, G. Tendon resection and tendon contraction for shortening the recti muscles. *N. Y. Med. Journ.*, 1889, No. 13, p. 345.

90. THOMPSON. Case of ocular palsy. *Brit. Med. Journ.*, 1889, Nos. 14, 71, p. 527.

91. WEBSTER, D. Some tenotomies for the correction of heterophoria, with results. *Amer. Ophth. Soc.*, 1888.

92. WESTPHAL. Progressive ocular paralysis. *Münchener med. Wochenschr.*, 1889, No. 4.

ÉPERON (85) discusses the operative treatment of the paralytic vertical deviations of the eye. In the introduction he discusses the thirteen cases thus far described by five authors; the paper of Alfr. Graefe (*Arch. f. Oph.*, vol. xxxiii., 3, p. 179) receives special attention. Éperon then reports six new cases observed by himself. Of the conclusions at which he arrives the following may be noted: Both from a surgical and practical point of view the superior rectus and inferior oblique muscles may be considered as acting together in raising the eye, the inferior rectus and superior

oblique muscles in depressing it, although physiologically this is not quite correct. The effect of paralysis of the superior oblique may be counteracted by advancement of the inferior rectus of the same or the superior rectus of the other eye; the former is to be preferred. In a similar manner paralysis of the inferior oblique may be corrected by advancement of the superior rectus of the affected, or tenotomy of the inferior rectus of the same, eye. Éperon is opposed to the compensating tenotomy of the associate muscle of the healthy eye as advised by A. v. Graefe and A. Graefe, as he considers the result uncertain; tenotomy of the inferior rectus especially should be avoided as much as possible, as the resulting operative insufficiency may give rise to asthenopic trouble for near vision. The effect of advancement can be altered more readily after the operation than that of tenotomy, and it is more certain. The effect can be changed from 0 to 10°. Even when the effect at first is excessive, it is not advisable to remove the sutures before the third day. In cases of slight deviation capsular advancement can take the place of advancement of the muscle with advantage. The above-mentioned operations do not have the undesirable effect on the inclination of the retinal meridians which might have been expected. MARCKWORT.

HADDEN (86) reports a case of muscular atrophy with partial ophthalmoplegia externa and interna. History of syphilis fifteen years before. WERNER.

HOWARD'S (87) case was that of a man of 54 years, who was previously healthy and free from syphilis. The invasion of the nervous symptoms, after he was first seen, was as follows: Headache, irascibility, diplopia, strabismus, and slight ptosis of the left side. This gradually disappeared. Five months later gradual and permanent establishment of the same condition in the right side; then impairment of articulation, mastication, and deglutition; loss of sexual power; then, four months later, progressive loss of hearing on both sides; and a month later, rapid failure of vision in the right eye. This was the order of symptoms from time H. saw the patient. The symptoms he had when he first came under observation, and the order of which could not be determined, were: Loss of pupil-reflexes and accommodation, complete immobility of both eyes with darting pains in them; loss of patellar reflex; loss of sensitiveness of both corneæ and absence of corneal reflex; loss of tactile and thermal sensibility in the same branches of both fifth nerves. Unfortunately no autopsy was obtained.

BURNETT.

STERLING (88) relates several cases in which headache and other nervous symptoms were relieved by the use of weak prisms, and in some of which he had made a graduated tenotomy of a rectus muscle according to the method of Stevens. BURNETT.

After shortly reviewing the subject STEVENS (89) gives a description of his own method of resecting the tendon of a rectus muscle. He first makes a very small opening in the conjunctiva some distance back from the insertion of the tendon. Through this opening the tendon is grasped with a pair of very delicate forceps in the middle, just behind the insertion, and a division made up to the border on either side. A small plow or divulsor is then introduced and the tendon detached from the surrounding conjunctival tissue, after which it is drawn out through the opening by means of a fine traction-hook. So much of the tendon is then resected as is deemed necessary for the desired effect, in the form of a triangle, the apex being towards the body of the tendon. A needle armed with the finest silk (No. oooooo) is passed through the tendon at this apex, but not through the conjunctiva, and through the stump of the tendon next the cornea, and the suture tied, thus producing the shortening. The very fine instruments used for the operation are figured.

BURNETT.

THOMPSON (90) relates the case of a Hindoo æt. twenty-six, in whom complete paralysis of all the ocular muscles, internal and external, occurred in one eye after intermittent fever. No history of syphilis. There was anæsthesia of the conjunctiva and some proptosis. V was reduced to $\frac{1}{\infty}$, and there was slight congestion of the disc. The patient recovered with fair vision in two months, under treatment with iodide of potassium. WERNER.

WEBSTER (91) relates in detail the histories of 40 cases in which he has operated by tenotomy for heterophoria, or latent dynamic squint, and comes to the following conclusions: 1. No person should have a tenotomy performed solely because he is the subject of heterophoria. 2. Very slight degrees should be corrected where troublesome symptoms exist which may be due to the too great use of nervous force in co-ordinating the eyes. 3. Other means should be resorted to before trying tenotomy, but unnecessary delay should be avoided. 4. The tenotomies should be performed under cocaine. 5. In judiciously selected cases, when the operation is properly performed, the average results will be quite as satisfactory as the results of most other surgical operations.

BURNETT.

WESTPHAL (92) found in a case of progressive paralysis of the muscles of the eye marked hyperæmia of the oculomotor nucleus with numerous small extravasations of blood, less intense hyperæmia of the abducent nucleus.

X.—ORBIT AND NEIGHBORING CAVITIES.

93. BAKER, M. Penetrating wounds of the orbit. *St. Bartholomew's Hosp. Rep.*, vol. xxiv., p. 179. Report of cases.

94. BULLER, J. A case of pulsating exophthalmus probably due to rupture of the carotid artery in the sinus cavernosus. *Trans. Amer. Ophth. Soc.*, 1888.

95. COLLINS, E. T., and WALKER, C. H. Two cases of orbital cellulitis, with necrosis of the horizontal plate of the frontal bone, accompanied with cerebral abscess. *London Ophth. Hosp. Rep.*, vol. xii., 3, p. 281.

96. JOFFROY. Rapports entre l'ataxie locomotrice progressive et le goître exophthalmique. *Soc. méd. des. hôp.*, Dec. 1888 and Feb. 1889.

97. KIPP, C. J. A case of double vascular exophthalmos—recovery under intermittent compression of right carotid artery and the internal use of iodide of potassium. *Trans. Amer. Ophth. Soc.*, 1888.

98. JAMAIN. Cas d'exostose orbitaire double bilatérate et symétrique. *Ann. d'ocul.*, vol. ci., p. 59.

99. WALDHAUER, C., Sen. Foreign body in the orbit. *Deutsche Zeitschr. f. Chirurg.*, vol. xxix.

100. WHITE, W. H. The pathological and the central nervous symptoms in ophthalmic goitre. *Brit. Med. Journ.*, March, 1889, p. 699.

BULLER (94) relates briefly the histories of two cases of pulsating exophthalmus from traumatic rupture of the carotid artery in the cavernous sinus, and another one at some length. A young man of twenty-eight fell twenty feet, striking the right side of his head on a square piece of timber, and was unconscious for twenty-four hours. When seen there were exophthalmus, swelling of the lids, and strong pulsation and a bruit heard over the eye, which were relieved by pressure on the common carotid. The retina was slightly œdematous, V = $\frac{20}{100}$. The common carotid was ligated with complete relief of the symptoms, and V = $\frac{20}{20}$.

BURNETT.

COLLINS and WALKER's (95) patients, who were aged seventeen and fifteen respectively, developed orbital cellulitis in consequence of injuries apparently trivial in nature and unaccompanied by any external wound. There was no optic neuritis and no cerebral symptoms until a short time before death, in both cases. A suggestion is made that an abscess of the orbit should be opened on the outside, so as to procure free drainage when the patient lies on his side. WERNER.

JAMAIN (98) reports a case of bilateral osteoma of the orbit. The tumor occupied the upper inner wall in both eyes and was removed without any injurious consequences. The tumor removed from the left orbit weighed 55 grms., that from the right, 36 grms. MARCKWORT.

According to JOFFROY (96) morbus Basedowii and tabes frequently occur together. The former affection seems to develop first. Tabes alone can produce tachycardia and protrusion of the globe. Barié thinks the genetic connection between the two diseases can be sought in the fact that morbus Basedowii is due to a bulbar affection.

KIPP's (97) case was that of a feeble lady of seventy-six, who soon after falling noticed protrusion of the eyeballs, impairment of vision, and loud noises in the right side of the head. When first seen the protrusion amounted to 5 *mm* in the right and 4 *mm* in the left eye; mobility impaired. No visible pulsation, nor was any felt, but a bruit synchronous with the pulsation of the heart, could be heard over the right side of the head. Compression of the right carotid stopped the bruit completely, compression of the left only partially. Intermittent digital compression of the right carotid was instituted, and 5 grs. of iodide of potassium given three times daily. In three months and eleven days the bruit ceased and the left eye had gone back to nearly the normal position, right unchanged. A little over a month later the exophthalmus of the right eye had disappeared. BURNETT.

WHITE (100) records a very interesting necropsy in the case of a girl æt. nineteen, who suffered with exophthalmic goitre and died of pneumonia. The capillaries of the brain, more especially on the floor of the fourth ventricle, were congested; cervical glands slightly, thyroid much, enlarged; mucous membrane of digestive tract swollen and congested. Microscopic examination showed the thyroid vessels enlarged, new vesicles in process of formation, numerous leucocytes. In the central nervous system there was

evidence of slight inflammation at the level of the lower part of the olivary nucleus just under the posterior surface of the medulla. Numerous hemorrhages were found in the neighborhood of the sixth nuclei. WERNER.

XI.—CONJUNCTIVA, CORNEA, SCLERA, ANTERIOR CHAMBER.

101. ALFELD. On the prevention of infectious eye-diseases during the first week of life. *Zeitschr. f. Geburtshülfe u. Gynækologie*, vol. xiv.

102. BAKER, A. R. Some remarks on transplantation of the cornea and allied subjects. *Amer. Journ. Ophth.*, Jan., 1889.

103. BARRENECHEA. Contribution to the knowledge of the tumors of the eye. *Centralbl. f. porkt. Augenhk.*, 1889, No. 104.

104. BASEVI. Due casi di epitelioma congiuntivale. *Ann. di ottalm.*, vol. xvii., 5, p. 437.

105. CALLAN, P. A. Treatment of ulcers of the cornea. *Trans. Amer. Ophth. Soc.*, 1888.

106. CHISOLM, J. J. The transplanting of a rabbit's cornea into the human eye. *N. Y. Med. Rec.*, Jan. 5, 1889.

107. ELSCHNIG, A. The operative treatment of trachoma. *Wiener med. Blätter*, 1889, No. 14.

108. KIPP, C. J. Cocaine-conjunctivitis. *Trans. Amer. Ophth. Soc.*, 1888.

109. LAMHOFER. Blennorrhœa neonatorum. *Schmidt's Jahrb.*, vol. ccxxi., 2, p. 201.

110. MITTENDORF, W. F. Acute cocaine-conjunctivitis. *Trans. Amer. Ophth. Soc.*, 1888.

111. PARINAUD. Conjonctivite infectieuse paraissant transmise à l'homme par les animaux. *Soc. d'opht. de Paris*, Feb. 9, 1889.

112. TREITEL. Treatment of granular conjunctivitis by means of partial excision of the conjunctiva. *Therap. Monatshefte.*, 1889, 2 and 3.

113. VOSSIUS, A. On hyaline degeneration of the conjunctiva. *Beiträge z. path. Anat.*, von E. Ziegler, vol. v.

114. WÜRDEMANN. A peculiar tumor of the conjunctiva. *Amer. Journ. Ophth.*, 1888, No. 9.

According to AHLFELD (101) three kinds of conjunctival affections occur in the new-born : blennorrhœa, marked by the presence

of diplococci; purulent conjunctivitis, which always heals before the end of the first or second week, but shows no diplococci; and catarrhal irritation. Formerly Ahlfeld treated blennorrhœa with instillation of sublimate, now he only disinfects the mother, washes out the vagina before the birth of the child, and cleanses the eyelids immediately after birth of the head with fresh water. Since 1884 he had had no case of blennorrhœa, and far more than a year none of purulent conjunctivitis.

Baker (102) has only made experiments of corneal transplantations in rabbits, and though the cornea transplanted by the methods of Durr-Wolfe or v. Hippel united and remained transparent for a time, they invariably became opaque in the course of a few weeks. Besides giving a short history of the operation of corneal transplantation he gives an account of an experiment he made with the introduction of a glass bead into an opaque cornea, which was for a time successful in giving sufficient vision to distinguish large forms and colors. Burnett.

Barrenechea (103) describes a case of sarcoma of the conjunctiva, which occupied the inner side of the eyeball and exceeded the latter in size. It was removed with the globe.

Basevi (104) describes two cases of epithelioma which had developed on the ocular conjunctiva, both on the nasal side.

Dantone.

In addition to the other methods commonly employed in the treatment of corneal ulcers Callan (105) cleans the ulcerated surface with absorbent cotton and cauterizes it with a 10-gr. solution of nitrate of silver. This process may be repeated.

Burnett.

Chisolm (106) reports the performance of v. Hippel's operation of corneal transplantation, in accordance with the method laid down by v. Hippel himself, in which considerable success is claimed. The corneal trouble resulted from a burn with lime; and there was also symblepharon. V was said to have been increased from little more than perception of light to an ability to see his way about. Burnett.

Elschnig (107) removed a strip 6 *mm* wide and about 30 *mm* long from the fornix of both eyes of a patient affected with trachoma. When the wound is properly united the function of the eye is not impaired, neither by the resulting scars nor by the change in position of the neighboring parts of the conjunctiva, due to the scars. The eye and conjunctiva are kept just as moist

as before, and the movements of the eyeball and lids are not impaired.

KIPP (108) reports three cases of follicular conjunctivitis, which he believes were due to the use of cocaine. All three patients were over seventy, and the cocaine had been used from two to six months. BURNETT.

LAMHOFER (109) treats blennorrhœa neonatorum by wiping away the pus with cotton pledgets impregnated with a 4 % solution of salicylic acid, and washing out the eye every one or two hours with sublimate (1 : 5000). He is opposed to the treatment with nitrate of silver. By this treatment he has reduced the time the disease lasts to thirteen days.

MITTENDORF (110) relates three cases in which the continued use of cocaine produced conjunctivitis. BURNETT.

PARINAUD (111) saw three cases of a conjunctival affection which he particularly observed in butchers, and which he would ascribe to an infection with animal substances. Red or yellow proliferations appear upon the conjunctiva, which at first are semi-transparent, and may attain to the size of a pin-head. Besides these, smaller quite yellow ones are observed, which made Parinaud think at first of tuberculosis. In one case the granulations were confined to the conjunctiva of the tarsus of the upper lid ; in the other two the conjunctiva of the lower lid and of the globe was also affected, which the cornea in all remained free. The lids were swollen hard, and seemed to contain nodules resembling chalazia. In the region of the parotid there was inflammatory swelling, and suppuration sometimes followed. Abadie and Galezowski have seen similar cases. MARCKWORT.

During the last three years TREITEL (112) excised the conjunctival sac in 170 cases of trachoma. He cut out the whole fornix of the upper lid, a portion of the neighboring tarsus, and the corresponding part of the conjunctiva of the tarsus. The results were satisfactory.

VOSSIUS (113) observed two cases of hyaline degeneration of the conjunctiva, from which he describes the disease as follows : The conjunctival affection manifests itself in the development of tumors, which is not accompanied with pain or any serious inconvenience. The tumors take on either the form of ridges with a smooth surface, which spring from the fornix and neighboring conjunctiva of the tarsus, or they appear lobulated, intersected by furrows of greater or less depth, or as round nodules, which

develop in the conjunctiva of the tarsus. They are of a pale-red or yellowish-white color. Histologically they may be designated as proliferations of the adenoid tissue, attended with the development of capillary blood-vessels. The hyaloid degeneration affects the basis-substance of the adenoid tissue and the blood-vessels. The products of degeneration are quite distinct from amyloid.

In WÜRDEMANN'S (114) case the neoplasm occupied the conjunctiva of the upper lid, extended 4 *mm* backward from its margin, and extended about 2 *mm* beyond it. The hair-like neoplasm had a feathery appearance, and was about ¾ inch long. Microscopically it resembled the fœtal hair. BURNETT.

115. CASTAGNÉ. De l'emploi du fer rouge dans quelques affections de la cornée. Montpellier, 1889.

116. DUBOIS. Note sur l'action du chlorure d'ethylène sur la cornée. *Gaz. hebd. de méd. et de chir.*, 1888, No. 45, p. 715.

117. GORDON. Treatment of corneal ulcers with the galvanocautery. *Wjestnik Ophth.*, 1889, No. 1, p. 67.

118. LAWFORD, J. B. Notes of cases of epithelioma and sarcoma affecting the cornea and conjunctiva. *London Ophth. Hosp. Rep.*, vol. xii., 3, p. 263.

119. LEBER, TH. The occurrence of coagulated fibrine in the corneal tissue. *v. Graefe's Arch. f. Ophth.*, vol. xxxv., 1, p. 271.

120. PANAS. Action des inhalations du chlorure d'ethylène pur sur l'œil. *Arch. d'opht.* vol. ix., 1, p. 77.

121. RANDOLPH, R. S. Congenital corneal opacity in two sisters. *Amer. Journ. Med. Sci.*, Dec., 1888.

122. VERDESE, ANGL. Recherches expérimentales sur la perforation précoce de la membrane de Descemet dans les processus ulceratifs infectants de la cornée. *Arch. d'opht.*, vol. ix., 2, p. 147.

123. WANGER, E. Herpes corneæ. *Inaug. Diss.*, Lucerne, 1889, Meyer.

124. WOLFE. Total staphyloma of the cornea corrected by an operation. *The Lancet*, March, 1889, p. 569.

DUBOIS (116) has made some new experiments for the purpose of discovering the reason of the corneal opacity following the inhalation of chlorous ethylene. In close agreement with Panas, he finds that the corneal opacity is due to the chlorous ethylene which enters the anterior chamber. A piece of cornea placed in this chemical substance becomes very dry, but swells enormously when laid into water. MARCKWORT.

GORDON (117) obtained very satisfactory results by treating corneal ulcers with the galvano-cautery, especially when he punctured them. HIRSCHMANN.

LAWFORD (118) records two cases of epitheliomatous growths at the sclero-corneal junction. In one case ulceration of the cornea followed excision. Lawford thinks that such ulcerations are frequently of an epitheliomatous nature. He also reports a case of sarcoma at the sclero-corneal margin. The tumor increased rapidly one year after partial excision, and was again removed, but eighteen months later it reappeared. WERNER.

LEBER (119) thinks that under certain conditions coagulated fibrine may be found. Sometimes it assumes very peculiar shapes, so that it is recognized with difficulty as fibrine. Such deposits of fibrine occur when severe inflammatory irritation is followed by a copious transudation of fibrinous liquid from the blood-vessels of the iris and corneal margin. MAGNUS.

PANAS (120) repeated the experiments of Raphael Dubois on the effect of inhalations of chlorous ethylene on the cornea. In dogs which had inhaled three fourths of an hour from two to five times (exhausting more than 10 *cub. cm.* each time) Panas made the following observations: Marked injection of the conjunctiva, photophobia, and dilatation of the pupil; both conditions continue for several days. The cornea assumes the appearance of porcelain, but about a week afterwards begins to clear up from the periphery. Later inhalations fail to reproduce this opacity. The latter, however, was increased by subsequent inhalations if it had not entirely disappeared, while Dubois saw it vanish under such conditions. In opposition to Dubois, Panas also found normal or even diminished tension. He ascribes the opacity of the cornea to serous infiltration, the latter in turn being due to the destruction of the epithelium of Descemet's membrane. The corneal epithelium remains normal, Panas failing to observe the desiccation preceding the opacity, as maintained by Dubois. The other parts of the eye did not undergo any material change. v. MITTELSTÄDT.

RANDOLPH (121) reports the cases of two girls aged respectively four and twelve, in whom there was a congenital bluish opacity of both corneæ. It occupied the epithelial layer and the outer portion of the corneal tissue proper. Teeth bad, but not typical Hutchinson teeth. The author is inclined to ascribe the condition to intra-uterine inflammation, and to consider it of specific origin. BURNETT.

In a paper published in the *Arch. d'opht.*, vol. vii., No. 6, p. 526, VERDESE (122) describes the anatomical conditions found in a serpent corneal ulcer. Subsequently he inoculated the cornea of dogs and rabbits with pure cultures of staphylococcus aureus and albus, to determine the origin of hypopyon. In these animals, however, only simple ulcers developed, which soon healed. In guinea-pigs, on the contrary, there were ulcers with hypopyon in within from twenty-four to forty-eight hours afterwards. The eyes were then enucleated and examined. The drawings of the ulcers in different stages show that first a collection of cells forms close beneath Descemet's membrane, especially behind the floor of the ulcer, but separated from it by an almost normal layer of tissue. This aggregation of cells increases in size and soon perforates Descemet's membrane, producing an escape of pus into the anterior chamber. Subsequently the greater part of Descemet's membrane is destroyed. The condition in the human eye previously reported was quite similar.

v. MITTLESTÄDT.

WOLFE (124) objects to operations for staphyloma near the ciliary region. He describes a case in which he removed an elliptically shaped piece from a central corneal staphyloma and brought the edges together with sutures. WERNER.

(*To be continued in next number.*)

REVIEW.

Dr. E. FUCHS, Professor of Ophthalmology, University of Vienna, **Lehrbuch der Augenheilkunde.** 1889, 798 large octavo pages, with 168 wood-engravings in the text.

This is not only the newest but also one of the best text-books of eye surgery that we have become acquainted with. Paper, print, and engravings are unexcelled in quality and neatness. The same praise must be bestowed on the treatment of the subject from the beginning to the end. The anatomy of the different parts of the visual organ, with remarks on their physiology and the special modes of examination, precedes the description of the diseases. The work is essentially a text-book, and represents modern ophthalmology with rare clearness and completeness. The careful divisions and subdivisions of the subject matter render it most valuable to three classes of readers: (1) to the student, as a guide and companion in his clinical studies and the preparation for his examination; (2) to the practitioner, as a clear and reliable book of reference; and (3) to the teacher of ophthalmology, in arranging his lectures or making abstracts for his class.

Prof. Fuchs' book deserves and is sure to gain a great popularity.

EDITORIAL NOTICE.

It is intended to issue in future the numbers of these ARCHIVES in January, April, July, and October; four numbers, as heretofore, making one volume. The numbers of the German edition appear at irregular intervals, according to the material on hand. They are not yearly, as in the English edition, and do no longer correspond to the English. Our readers know that not all papers are translated in full from the one edition into the other, condensation being in the interest both of the readers and the authors. The same condensation has become necessary in the systematic reports. The authors are sure to have their papers published in their own language—unabridged, unaltered, and without any remarks on the part of the editors. Should the editors consider any change in an article desirable, they will obtain the author's consent before giving the paper to press. If a reader wants to refer to a paper in the original, the undersigned will send it to him, expecting to have it returned at the reader's earliest convenience.

H. KNAPP, M.D.

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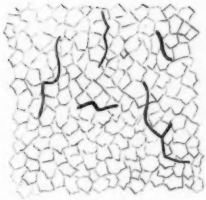

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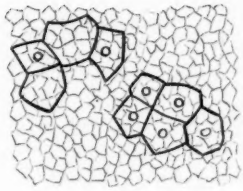

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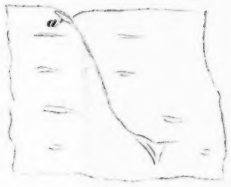

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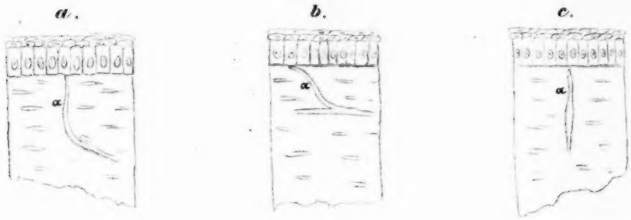

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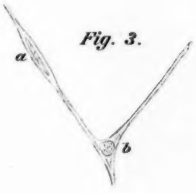

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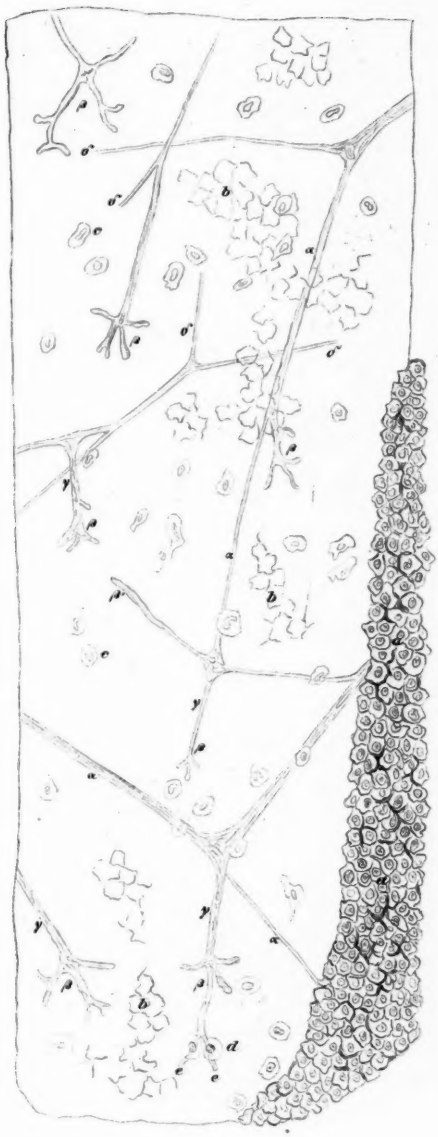

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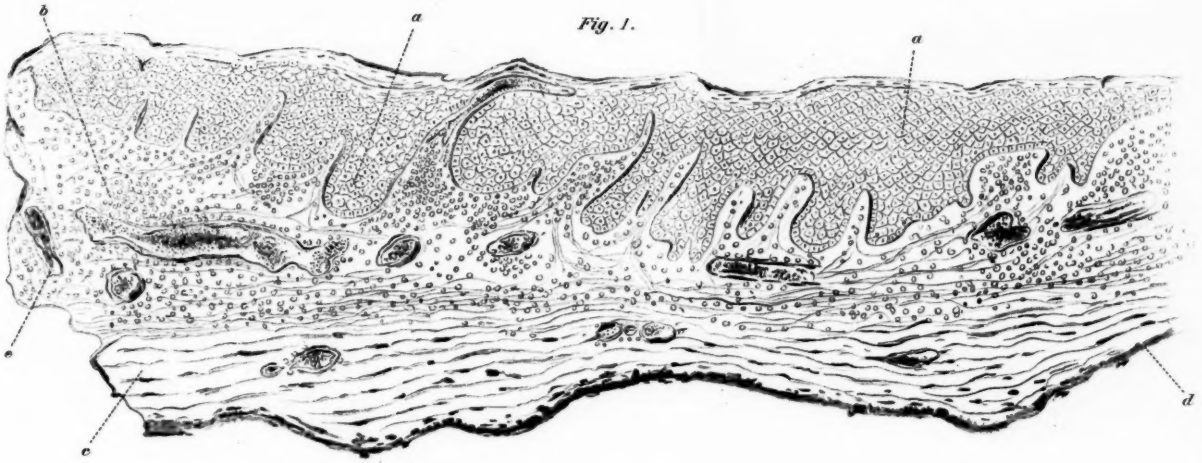

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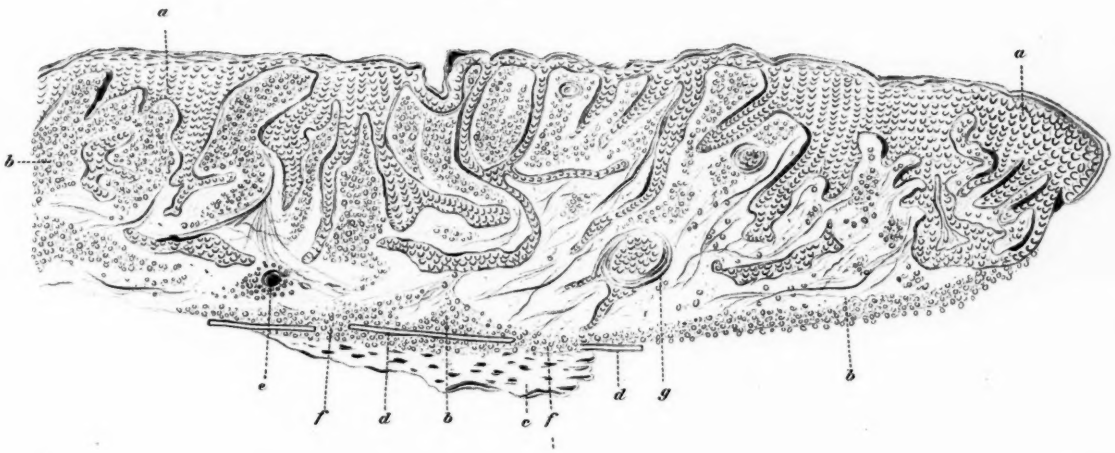

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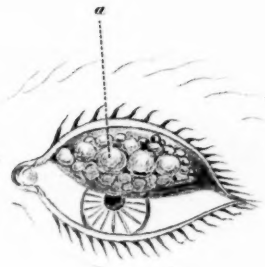

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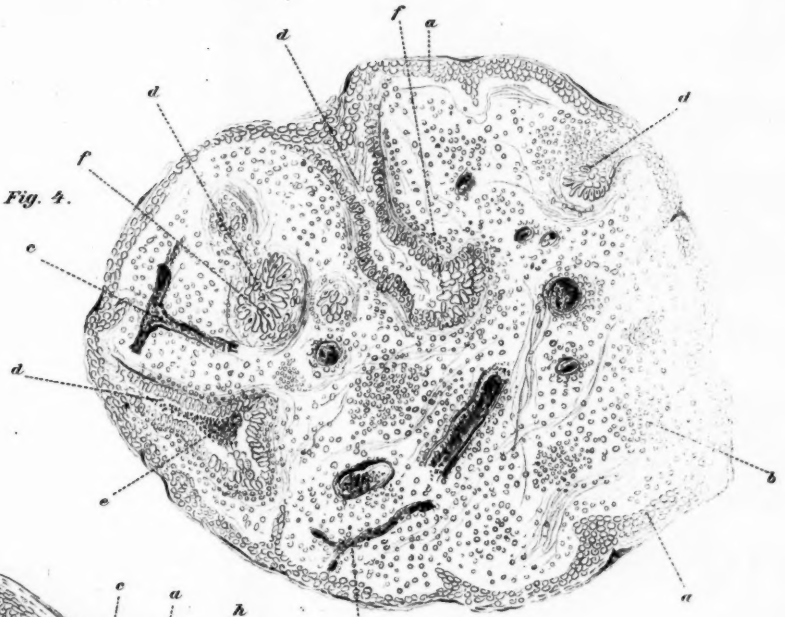

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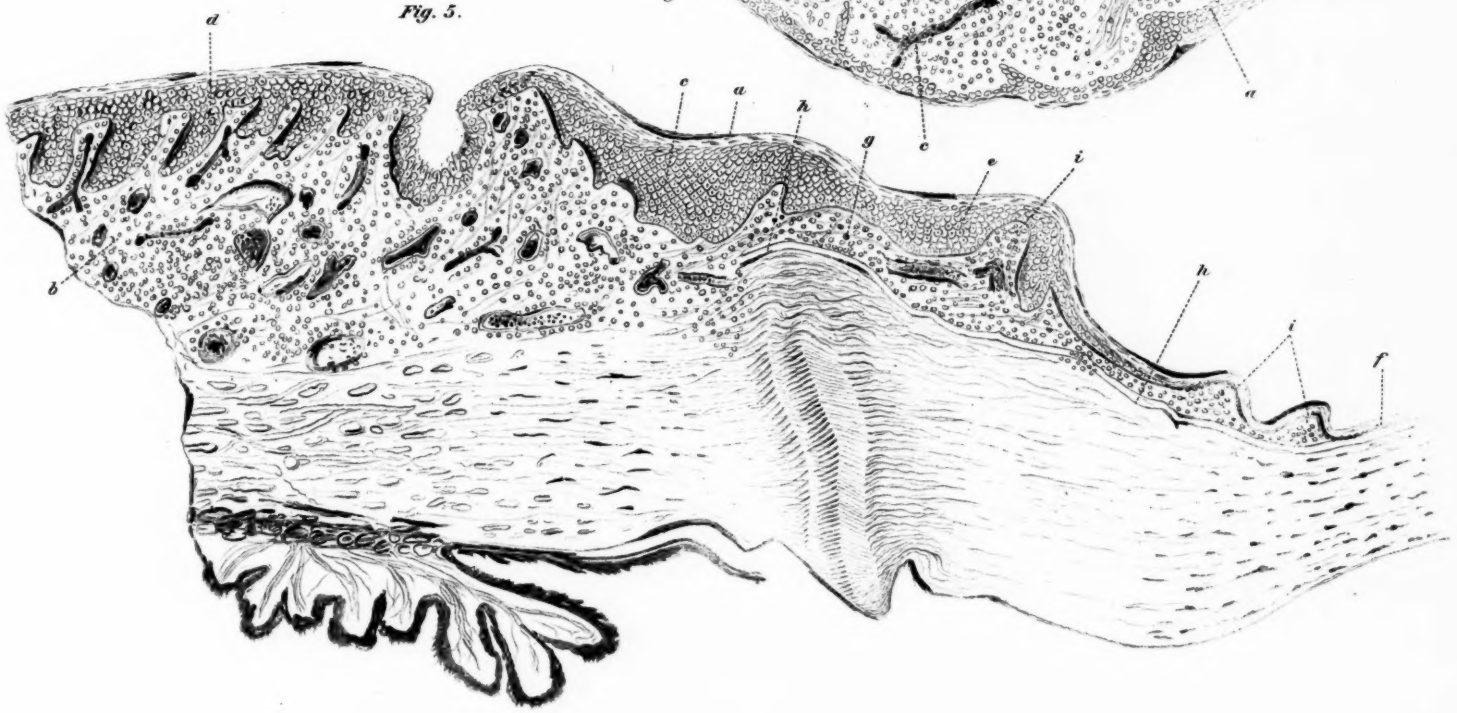

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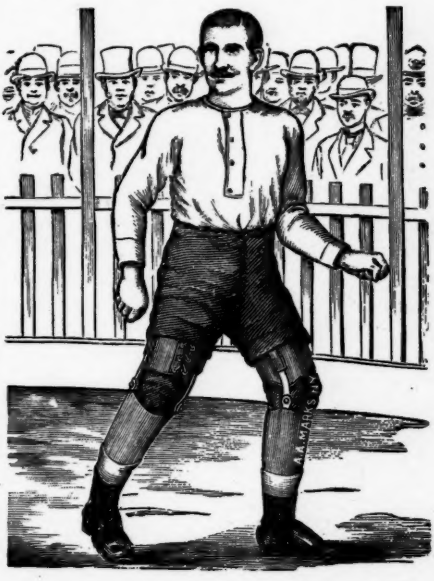

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